Improved Breeding Lines of Alfalfa

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ABSTRACT

This publication lists all alfalfa breeding lines or germplasm releases available to individual scientists and to organizations interested in the improvement of alfalfa. The breeding lines are listed under the releasing agency and are indexed by both the releasing agency and the characteristics of the germplasm.

KEYWORDS: Germplasm, breeding lines, host resistance, alfalfa population, germplasm pool, *Medicago*, botanical classification, morphological characters, cytogenetics, quality factors, physiological characters.

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PREFACE

This publication presents a listing and a description of improved breeding lines of alfalfa, which has been assembled by the National Alfalfa Improvement Conference Committee on Available Breeding Lines of Alfalfa. Germplasm releases included in this publication represent only breeding stocks such as clonal propogules of individual plants, seed of clones, or lines resulting from improvement programs. The germplasm possesses gene combinations with special characteristics or merit for use in breeding programs.

The proposal for this publication was approved by the 25th Alfalfa Improvement Conference held on July 13-15, 1976, at Ithaca, N. Y. Members of the Committee and authors of this report are:

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The Committee has compiled a listing of germplasm releases included in each of the biennial proceedings of the National Alfalfa Improvement Conference. This publication combines those listings and serves as a complete reference of available breeding lines of alfalfa so that this information will be more readily

available to a larger segment of the alfalfa research community. The Committee recommends that the germplasm list be updated periodically.

The term "cultivar," recommended by the International Code of Nomenclature for Cultivated Plants and defined by Gilmour et al., American Horticultural Society, 32 pages, 1969, is used instead of the somewhat less specific term "variety."

A cultivar is defined as "a group or assemblage of cultivated individual plants that when reproduced sexually or asexually retain their distinguishing features that have been described morphologically, physiologically, cytologically, chemically or in other ways that have significant meaning to agriculture, horticulture, or forestry." It may be a clone, a line, an assemblage of individuals, or a uniform first-generation hybrid reconstituted in each generation by the crossing of two or more breeding stocks maintained either by inbreeding or as clones.

The term is derived from *cultivated variety*. It is more specific than a morphological variant of a botanical species, but in the sense of a cultivated variety the term cultivar and variety are exact equivalents.

The singular is abbreviated "cv," and the plural, "cvs." Capital initial letters are required for all words of a cultivar, the word or words placed in single quotes for example, alfalfa (*Medicago sativa* L.) cv. 'Kansas Common'.

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IMPROVED BREEDING LINES OF ALFALFA

INTRODUCTION

The objectives of alfalfa improvement programs throughout the world differ only in emphasis placed on specific objectives. Generally, there are elements common to all programs because the major cultural and production problems are seldom geographically isolated. Because of these common objectives, because of the need to expedite the development and release of improved cultivars, and because of the rapidly changing attitudes on cultivar development by public research agencies and the seed industry, we need to continue to have an effective system for the exchange of plant germplasm.

Distribution and interchange of germplasm were carried on among public plant breeders until the early 1960's. These exchanges were made informally, often between two scientists. Elements of change have taken place in the alfalfa industry and in the public research sector that make necessary more effective distribution and use of available germplasm. The number of selection criteria in improvement programs has been increasing at an accelerated rate. Until 1950, we were only concerned with the improvement of bacterial wilt resistance and climatic adaptation. Today, alfalfa breeders have comprehensive and concentrated improvement programs aimed at host resistance to 21 diseases, three nematode species, and five insect as well as several more complex attributes such as nonbloating to ruminants, improved nitrogen fixation, several quality factors, and physiological characteristics.

Along with the increase in the number of criteria has come an increase in the complexity of these traits. Alfalfa hay and seed acreages and values are increasing; therefore, alfalfa breeding as a commercial enterprise has grown rapidly within the past 20 years. There is a new sophistication in our approach to breeding alfalfa and an increasing knowledge in the application of genetic principles to plant breeding and to the development of improved cultivars. The rapid increase in the number of characteristics needing improvement has increased the need for more cultivars to fit into regional or local production environments. Individual research programs cannot practically develop and maintain the expertise for improving the increasing number of characteristics recognized as important in modern cultivars.

The recognition of germplasm exchange as one means of meeting the demands of the expanding and changing alfalfa improvement programs was illustrated when this was delineated as one of three major problems to be considered by the First Joint Alfalfa Work Conference in 1960. This conference described the kinds of germplasm considered for release or exchange.

The development of formal germplasm exchange policies among the State Agricultural Experiment Stations, the U.S. Department of Agriculture (USDA), and the

Seed Industry has evolved over a long period. The Experiment Station Committee on Organization and Policy (ESCOP) report in 1954 formally recognized this responsibility in its "Statement of Responsibilities and Policies Relating to Seeds." The National Alfalfa Improvement Conference, meeting at St. Paul, Minn., in 1956, recommended an amplification of the ESCOP report as a guideline for implementing the policy as it related to alfalfa as follows:

(1) Not all clonal material is necessarily 'basic genetic material' because the clones may be in the 'course of development.'

(2) Breeder seed of released varieties is considered to be 'basic genetic material' and when available,such seed may be released in small quantities for testing and as source material for breeding purposes.

(3) In the case of specific requests for material having a particular genetic characteristic, such as resistance to a given insect or disease, and where such a characteristic is not available in the form of breeder seed, the request should be filled, if possible, with open-pollinated, polycross, or inbred seed of lines, which have genetic properties of the kind requested, provided the lines are not in themselves under active consideration for use in a proposed new cultivar.

(4) In all cases, only the originating station or agency shall have the prerogative of distributing or authorizing the distribution of basic genetic materials.

The recommendations of the First Joint Alfalfa Work Conference resulted in the appointment of a committee by the Chairman of the 18th National Alfalfa Improvement Conference in 1962 to study the development of procedures by which available breeding lines could be made known to interested persons. This action resulted in the appointment, in 1964, of a committee to assemble information on new alfalfa breeding lines or germplasm released either officially or unofficially by public or private sources. This committee has continued to assemble information on available breeding lines and has made it a part of the National Alfalfa Improvement Conference proceedings.

Agencies and individuals responsible for alfalfa improvement programs have been urged to release germplasm and to register these releases in Crop Science, the official publication of the Crop Science Society of America (CSSA). This documentation provides a worldwide recognition and a historical record of the parent stocks and breeding methods used to develop them. The CSSA Alfalfa Registration Subcommittee, in a memorandum to all alfalfa breeders in the United States and Canada, in 1976, pointed out the value of cultivar and germplasm registration and briefly outlined the procedure for registration. The complete procedure is outlined in Crop Science (*1*).[1]

The Committee on Preservation of Germplasm of the National Alfalfa Improvement Conference, in its report to the conference in 1976, raised the question of maintenance and storage of domestic germplasm releases and available breeding lines. All agencies involved in alfalfa improvement are further urged to consider

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[1]Italic numbers in parentheses refer to Literature Cited, p. 42.

the official release of improved breeding lines or germplasm accompanied by a full description and subsequent submission of samples for preservation in the National Seed Storage Laboratory, Fort Collins, Colo.

GERMPLASM DESCRIPTIONS

Seed Stocks

ALASKA: Contact L. J. Klebesadel, Institute of Agricultural Sciences, University of Alaska, Palmer, Alaska 99645.

A-Syn B: Developed by the Institute of Agricultural Sciences, University of Alaska, and the Science and Education Administration (SEA), USDA, Palmer. A-Syn B evolved through natural selection at the College Research Farm and was tested as 'Fairbanks composite' or 'Fairbanks sativa'. The cultivars 'Buffalo', 'Rhizoma', 'Cossack', 'Nomad', 'Grimm', 'Ladak', 'Ranger', 'Narragansett', and 'Atlantic' as well as other strains were included in the plots from which this germplasm was selected. Winter survival of A-Syn B was described by Klebesadel in 1971 (*36*).

ARIZONA: Contact M. H. Schonhorst, Department of Plant Sciences, University of Arizona, Tucson, Ariz. 85721.

PA-1: Developed by the Arizona Agricultural Experiment Station (AES), University of Arizona, Tucson, and the SEA. PA-1 is a moderately broad-based, nondormant alfalfa developed by (1) selecting 160 plants from 15 superior alfalfa cultivars and experimentals for resistance to the pea aphid, *Acyrthosiphon pisi*; (2) screening of Syn-1 seedlings, obtained from the first cycle of selection for pea aphid resistance, for resistance to both the pea aphid and the spotted alfalfa aphid, *Therioaphis maculata* (Buckton); (3) selecting 118 plants resistant to both aphids and intercrossing them to produce Syn-1 generation seed of the second cycle of selection for pea aphid resistance; and (4) producing Syn-2 generation seed of this material to be released as PA-1.

PA-1 has a superior level of resistance to the pea aphid. In evaluation tests at Tucson, mean percent seedling survival of PA-1 was 92; 'Dawson', 72; experimental T-3-12, 68; 'Washoe', 57; and 'Caliverde', the susceptible check, zero. Resistance to biotype H of the spotted alfalfa aphid was moderately high. Seedling survival was 63 percent compared with 94 percent in the resistant experimental check AZ MSTT.

PA-1 is recommended for incorporating a superior level of pea aphid resistance into existing nondormant cultivars lacking adequate levels of resistance or to increase current levels of pea aphid resistance in other cultivars. No claims are made for general combining ability for forage yield; however, seedling vigor in PA-1 was as high or higher than in any of the alfalfas cited above.

CALIFORNIA: Contact L. R. Teuber, Department of Agronomy and Range Science, University of California, Davis, Calif. 95616.

UC38 and UC47: Developed by the California AES, University of California, Davis, and Riverside (*38*). UC38 is a nondormant germplasm segregating for

tolerance to Phytophthora root rot caused by *Phytophthora megasperma*, as well as resistance to the spotted alfalfa aphid, pea aphid, and downy mildew. UC38 was produced by intercrossing 614 unselected F_1 plants with parentage tracing to 'African' (40 percent), 'Arabian' (50 percent), 'Lahontan' (8 percent), and 'Sirsa' (2 percent). UC38 has a tolerance to Phytophthora root rot similar to that in 'Lahontan' but better than that in 'African' and 'Moapa'.

UC47 is a nondormant germplasm segregating for tolerance to Phytophthora root rot caused by *Phytophthora megasperma*, as well as resistance to the spotted alfalfa aphid, pea aphid, and downy mildew. It originated from eight parent clones of good agronomic type from parentage tracing to 'African' (62 percent), 'Arabian' (28 percent), 'Lahontan' (9 percent), and 'Sirsa' (1 percent). Tolerance to Phytophthora root rot in UC47 is similar to that in 'Lahontan' and better than that in 'Moapa' and 'African'.

UC38 and UC47 contain an array of genotypes ranging from susceptible to highly tolerant to Phytophthora root rot and are intended as a source from which selection for Phytophthora tolerance can be made (*17*, *37*).

SW44: Developed by the California AES, University of California, Davis, in cooperation with the SEA. SW44 is a 16-clone synthetic segregating for resistance to stem nematode, leaf and stem diseases, and levels of nondormancy. Parent clones were selected from four experimental synthetics planted in a field heavily infested with stem nematode near Santa Maria, Calif. Parentage traces to 'African' (42.6 percent), 'Caliverde' (37.5 percent), 'Lahontan' (18.6 percent), and 'Sirsa' (1.6 percent). SW44 should provide germplasm for the development of varieties adapted to areas where nondormant alfalfa is desired and where stem nematode is a problem.

Forage production of SW44 was equal to or better than that of 'Moapa' at El Centro and Davis, Calif., through the first production year. Production improved during the second and third year at Davis and the third year at El Centro. Reaction to the pea aphid and spotted alfalfa aphid compares favorably with that of other varieties. Observations on plant height, Stemphylium leaf spot, and stand made in the humid coastal environment of Santa Maria, where stem nematode was a problem, indicate its superiority in this environment (*39*).

UC64: Developed by the AES, University of California, Davis, in cooperation with the SEA. UC64 is the bulked seed produced on 44 clones selected for high resistance to spotted alfalfa aphid biotype ENT F and for tolerance to pea aphid. Initially, 222 clones were selected from five University of California experimental varieties in seedling tests for resistance to biotype ENT A of the spotted alfalfa aphid and tolerance to the pea aphid. These clones were combined into two synthetics, UC54 and UC55, and were tested for field reaction to spotted alfalfa aphid biotype ENT F and forage production. The 222 parent clones were reduced in number to 44 during a heavy, prolonged field attack of ENT F, and later intercrossed to produce seed of UC64. Parentage of UC64 traces to 'African', 'Sirsa', 'Arabian', 'Lahontan', and a population tracing to 30 varieties. UC64 will probably provide high resistance to all known biotypes of the spotted alfalfa aphid, tolerance to the pea aphid, good winter growth, and production capability comparable to the varieties being grown in the low desert valley areas. The superior performance of UC64 in seedling survival tests with four biotypes of the spotted alfalfa aphid is shown in table 1.

For pea aphid reaction, UC64 was superior to 'Caliverde' and 'Moapa' but inferior to 'Washoe' (table 1). Average forage yields of UC54, UC55, and check cultivars for a 1-year period in percent of 'Sonora' were as follows: UC54 (104), UC55 (103), 'Sonora' (100), 'Mesa-Sirsa' (103), and 'El-Unico' (103). Spotted alfalfa aphid damage scores under field infestation with populations of biotype ENT F were UC54 (1.7), UC55 (1.0), 'Moapa' (4.8), 'Sonora' (2.8), 'Mesa-Sirsa' (2.8), and 'El-Unico' (2.0) (1 = resistant and 5 = susceptible).

TABLE 1.--*Percent seedling survival of UC64 and 4 alfalfa cultivars to 4 biotypes of the spotted alfalfa aphid and to the pea aphid*

	Spotted alfalfa aphid biotypes				
Alfalfa entry	ENT A	ENT C	ENT E	ENT F	Pea aphid
UC64	89.6	89.9	87.4	78.9	49.0 b[1]
Moapa	7.6	39.7	2.5	0	29.8 c
Mesa-Sirsa	90.6	85.0	74.1	57.9	45.3 b
Washoe	68.7	73.2	79.0	64.7	63.6 a
Caliverde	0	0	0	0	0 d

[1]Values followed by the same letter are not significantly different at the 5-percent level.

COLORADO: Contact C. E. Townsend, USDA, SEA, Crops Research Laboratory, Colorado State University, Fort Collins, Colo. 80523.

C-3: Developed by the USDA, SEA, Fort Collins, in cooperation with the Colorado AES, Colorado State University (*47*). C-3 is a dryland alfalfa germplasm pool with valuable characteristics for selection and breeding.

This pool consists of 63 cultivars, experimental synthetics, breeding populations, and released germplasm, which possess characteristics that will be valuable in a dryland alfalfa breeding program. Many entries were selected because of their known adaptability to the environmental conditions of the central and northern Great Plains. Consequently, they possess high levels of winterhardiness and can withstand rather prolonged periods of drought. Phenotypic diversity within the pool for growth habit, leafiness, flower color, and other characters was great. Growth habit ranged from low-growing to upright and included creeping, noncreeping, and broad-crowned types. Some entries initiated growth early in the spring and after cutting; whereas, others were relatively slow to initiate growth. There was considerable variability for leaf size and number and for coarseness of stems. Flower color ranged from yellow to purple to white, and included the different variegated forms. Some entries had some *Medicago falcata* parentage. Bees cross-pollinated flowers in each cycle.

Cycle 1 seed was produced in 1973 from a replicated spaced-plant nursery, which consisted of more than 5,000 plants. Seed was harvested by hand from every plant that set seed. Cycle 1 seed was maintained on a progeny basis. The seed was scarified and planted at a relatively low seeding rate to produce cycle 2 seed in 1974. Both cycle 1 and cycle 2 seed were produced at Fort Collins.

C-3 is cycle 2 seed and is a blend of equal quantities of seed (by weight) of the 63 entries.

ILLINOIS: Contact D. A. Miller, Department of Agronomy, University of Illinois, Urbana, Ill. 61801.

Illinois 76-1 and Illinois WE-47: Developed by the Illinois AES, University of Illinois, Urbana. Illinois 76-1 (Ill 3-71-44-1) traces back to rapid-growing selections, with no or very little fall dormancy. Twenty-two clones were selected from two cycles of phenotypic recurrent selection. This line was derived from random intercrossing of two clones selected for early spring growth, lack of fall dormancy, and moderate resistance to alfalfa weevil. Various characteristics are as follows: Deep-purple flower color, high forage yield, stems taller than most cultivars by about 4 or 5 inches, more resistant to alfalfa weevil as compared with the cultivar 'Weevlchek', moderate resistance to bacterial wilt, and protein content higher than average cultivars (table 2).

Illinois WE-47 consists of 12 clones, developed from a cycle 3 recurrent selection program, which were selected from a 1,000-plant population. The original population consisted of 11 plants selected by a laboratory technique for resistance to alfalfa weevil (tables 3 and 4). These clones were randomly intercrossed and screened for resistance to the alfalfa weevil in southern Illinois and southern Indiana. Individual plants were dug and randomly crossed in the greenhouse. From a 1,000-plant population, the best 17 plants were selected for cage seed increase. Plant characteristics are as follows: Medium-blue flower color, moderate resistance to bacterial wilt, high protein content, good resistance to alfalfa weevil, slight fall dormancy, and dark-green leaf color.

INDIANA: Contact R. C. Pickett, Department of Agronomy, Purdue University, Lafayette, Ind. 47907.

Indiana Syn C: Developed by the Indiana AES, Purdue University, West Lafayette (*46*). Indiana Syn C is a six-clone synthetic alfalfa with a high amount of resistance to the potato leafhopper and should be useful germplasm source in the development of new varieties.

The six clones from which Indiana Syn C was derived were developed in the Purdue University breeding program. The germplasm contains resistance, which is more than plant tolerance to attack. Population data have shown that significantly lower leafhopper populations have survived in comparison with other breeding materials. These population differences are believed due to antibiosis or nonpreference.

Limited testing to date indicates that the genetic yielding ability of this synthetic is comparable or slightly superior to 'Vernal'. It is inferior to 'Vernal' for resistance to bacterial wilt, approximately equal to 'Vernal' for resistance to Phytophthora root rot, and has about the same or slightly less fall dormancy than 'Vernal'.

TABLE 2.--*Yields of dry matter of alfalfa cultivars and experimentals at locations in Illinois, 1971-75 (after D. A. Miller, Urbana, Ill.)*

Entry	Yield	Yield (2-yr average)	Checks	Checks (2-yr average)	Weevil rating[1]
	Tons/acre	*Tons/acre*	*Percent*	*Percent*	
Northern Illinois, seeded May 15, 1973:					
Ill 3-71-44-1	5.21	4.70	116	116	- - -
Four checks	4.50	4.04	100	100	- - -
Weevlchek	5.01	4.49	110	111	- - -
Urbana, seeded April 30, 1973:					
Ill 3-71-44-1	5.30	4.94	110	111	2.2
Four checks	4.83	4.44	100	100	4.1
Weevlchek	4.42	4.25	91	96	2.8
Urbana, seeded April 12, 1971:					
Ill 3-71-44-1	6.20	5.01	111	109	2.1
Check (Vernal)	5.59	4.59	100	100	4.0

[1]0 = no damage; 1 = less than 5-percent tip damage; 2 = 15-20-percent tip damage; 3 = 25-40-percent tip damage; 4 = 50-75-percent tip damage; 5 = 85-100-percent tip damage.

IOWA: Contact Irving Carlson, Department of Agronomy, Iowa State University, Ames, Iowa 50011.

IOWA 3018: Developed by the Iowa AES, Iowa State University, Ames. Iowa 3018 is the Syn 3 generation of an 11-clone experimental synthetic alfalfa cultivar with yellow flowers. The main value of this germplasm is as a genetic marker.

KANSAS: Contact E. L. Sorensen, USDA, SEA, Department of Agronomy, Kansas State University, Manhattan, Kans. 66506.

KS10: Developed by the SEA in cooperation with the Kansas AES, Kansas State University, Manhattan (*45*). KS10 is a 95-clone synthetic alfalfa derived from

TABLE 3.--*Yield of dry matter and weevil damage ratings of alfalfa cultivars and experimentals seeded April 15, 1975, at Urbana, Ill.*

Entry	Yield	Checks	Weevil rating[1]	Protein level
	Tons/acre	*Percent*		*Percent*
Ill WE-47	2.93	103	1.5	24.0
Four checks	2.84	100	4.5	19.8
Weevlchek	3.04	107	3.0	20.4

[1]0 = no damage; 1 = less than 5-percent tip damage; 2 = 15-20-percent tip damage; 3 = 25-40-percent tip damage; 4 = 50-75-percent tip damage; 5 = 85-100-percent tip damage.

TABLE 4.--*Alfalfa weevil damage in small observation plots at southern Indiana and southern Illinois in 1974-75*

Entry	Southern Indiana		Southern Illinois	
	1974	1975	1974	1975
Ill WE-47	[1]1.8	1.7	2.0	1.8
Weevlchek	3.1	2.9	2.9	3.0

[1]0 = no damage; 1 = less than 5-percent tip damage; 2 = 15-20-percent tip damage; 3 = 25-40-percent tip damage; 4 = 50-75-percent tip damage; 5 = 85-100-percent tip damage.

'Ladak' by recurrent selection. Sixty-two spotted alfalfa aphid resistant plants were selected from approximately 50,000 'Ladak' plants on the basis of seedling survival after infestation and failure of plants to support aphid colonies. Similarly, 18 pea aphid resistant plants were selected from about 500 'Ladak' plants. The 80 selections were planted systematically in a seed production nursery to facilitate recombination between the two groups of aphid resistant plants. Independent culling was utilized in two subsequent cycles to select for combined resistance to the pea aphid and spotted alfalfa aphid. Two hundred plants were recombined in the second cycle and 95 in the third cycle. In the last cycle, selection was made also for resistance to bacterial wilt.

Based on percent seedling survival after infestation, KS10 is resistant to the pea aphid (75 percent), 'Ladak' (4 percent), 'Dawson' (59 percent), 'Kanza' (84 percent), and 'Washoe' (62 percent); L.S.D. .05 = 12). KS10 is also resistant to the biotypes of the spotted alfalfa aphid found in 'Kansas' (KS10 (21 percent), 'Ladak' (4 percent), 'Dawson' (61 percent), 'Kansa (88 percent), and 'Washoe' (79 percent seedling survival); L.S.D. .05 = 15). In a bacterial wilt field test at St. Paul, Minn., wilt indices (0 = healthy, 5 = dead) for KS10 and three check cultivars were as follows: KS10 (2.65), 'Vernal' (2.46), 'Ladak' (3.56) and 'Narragansett' (4.10).

Spring and fall growth habit and recovery after cutting of KS10 more nearly approached that of 'Vernal' than that of a certified Canadian lot of 'Ladak'. KS10 was compared with other experimental synthetics and varieties in 10 north-central States. At each location except South Dakota, its forage yields exceeded those of its parent variety. Average forage yields of KS10, under irrigation at Manhattan and dryland conditions at Hays, Kans., exceeded those of certified 'Ladak' seed lots obtained from seven States and Canada.

Seed yields of KS10 in California exceeded those of 'Ranger' and 'Vernal', the two control cultivars.

KS76, tested as KS12B4PA4SA4M3L1, was derived from 'Kanza' alfalfa by recurrent phenotypic selection. Utilizing successive elimination in the seedling stage under controlled conditions in the laboratory, four cycles of selection for resistance were completed for bacterial leaf spot, pea aphid, and spotted alfalfa aphid; three cycles for downy mildew; and one cycle for Leptosphaerulina leaf spot. Resistant plants were evaluated under field conditions, and the elite were intercrossed by hand in the greenhouse to initiate each cycle. Seventy-one plants from the last cycle were intercrossed in the greenhouse to produce Syn 1 seed. Syn 2 seed was produced in a isolated field plot.

More than 95 percent of KS76 plants are resistant to bacterial leaf spot compared with 0.1 percent for 'Kanza'. The bacterial wilt resistance of this new germplasm is more than double that of highly resistant 'Vernal'. Under field conditions, downy mildew resistance of KS76 and that of 'Saranac' were similar; however, in a severe seedling test under laboratory conditions, 'Saranac' was the more resistant of the two. In field tests, anthracnose resistance of 'Arc' and KS76 was not significantly different. The new germplasm is moderately resistant to summer black stem. Its reaction to Leptosphaerulina leaf spot has not been evaluated. Pea aphid and spotted alfalfa aphid resistance of KS76 and 'Kanza' are about equal.

At Manhattan, in a 2-year irrigated trial, forage yields of KS76 were 108 percent of those of the average of 'Dawson', 'Kanza', 'Saranac', and 'Vernal'. Spring growth was similar but recovery after cutting was slower than that of 'Kanza'. Fall dormancy is intermediate between that of 'DuPuits' and 'Saranac'.

KS77: Derived from 'Arc' alfalfa by recurrent phenotypic selection in the seedling stage. Successive elimination under controlled conditions in the laboratory included one cycle of selection for resistance to Phytophthora root rot, two cycles for downy mildew, and three cycles each for the pea aphid and spotted alfalfa aphid. More than 75 resistant plants were utilized to initiate each cycle of selection. Eighty-three plants from the last cycle were intercrossed by hand in the greenhouse to produce Syn 1 seed. Syn 2 seed was produced in an isolated field plot.

In a Phytophthora root rot field test at St. Paul, resistance of KS77 was about equal to that of 'Agate' (KS77 = 31, 'Agate' = 34-percent resistant). Resistance to downy mildew, in a seedling trial under controlled conditions in the laboratory, was 235 percent that of resistant 'Saranac'. Based on percent seedling survival after infestation, KS77 is resistant to the pea aphid (KS77 (88 percent), 'Arc' (43), 'Kanza' (73), and 'Ranger' (6)). KS77 is also resistant to the biotypes of the spotted alfalfa aphid in 'Kansas' (KS77 (78 percent), 'Arc' (0), 'Kanza' (77), and 'Ranger' (8)).

Seedling-year forage yields of KS77 exceeded those of 'Arc' in an irrigated trial at Manhattan. Recovery after cutting and fall growth habit of KS77 and 'Arc' were similar during the year of establishment.

KENTUCKY: Contact N. L. Taylor, Department of Agronomy, University of Kentucky, Lexington, Ky. 40506.

KYZ-1: Developed by the Kentucky AES, University of Kentucky, Lexington. KYZ-1 is a creeping-rooted alfalfa germplasm.

MINNESOTA: Contact D. K. Barnes, USDA, SEA, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minn. 55108.

MnP-B1 and MnP-D1: Developed by the SEA in cooperation with the Minnesota AES, University of Minnesota, St. Paul (*18*). MnP-B1 is the interpollinated seed produced on 160 alfalfa plants selected in 1969 for resistance to *Phytophthora megasperma*. Initially, about 25,000 seeds of winter-hardy and moderately winter-hardy varieties were planted in an irrigated Phytophthora nursery at St. Paul. Plants with the least root damage in the field were taken to the greenhouse and retested for resistance. The most resistant plants were selected from 29 varieties and experimental strains. These included 'Apalachee', 'Beaver', 'Buffalo', 'Cayuga', 'Cherokee', 'Cody', 'Cossack', 'Culver', 'Flamande', 'Ladak', 'Lamix', Meeker Baltic', 'Williamsburg', WL 303, 153, 522, Minn. Syn. N., Minn. Syn. 0, and MSA and MSB populations. Seed was increased under isolation in California by the NC-83 regional project.

MnP-D1 is the interpollinated seed produced on about 90 plants selected in 1969 for Phytophthora resistance. Initially, about 7,000 seeds of alfalfa varieties adapted to the southwestern United States were planted in an irrigated Phytophthora nursery at St. Paul. Plants selected from the field were retested in the greenhouse for resistance. Resistant plants were selected for intercrossing from 14 varieties and experimental synthetics. These included 'Indian', 'Lahontan', 'Mesa-Sirsa', 'Moapa', 'Peruvian', 'San Isidro', 'Sonora', 'Turkistan', 'Washoe', UC Expt. 38, and UC Expt. 47. Seed of MnP-D1 was increased under isolation in Nevada by O. J. Hunt.

The degree of Phytophthora root rot resistance of Mn*P*-B1, Mnp-D1, and 135 varieties was evaluated in field tests at St. Paul in 1970 and 1971. MnP-B1 and MnP-D1 were approximately equal in resistance to 'Lahontan' and 'Washoe', but superior to that of all other varieties tested. Phytophthora root rot resistance plus their broad genetic backgrounds should make these valuable populations from which to isolate adapted as well as pest-resistant germplasm.

Seventeen BIC Populations: Developed by the SEA in cooperation with the Kansas, Minnesota, Nebraska, Nevada, and Washington AES. Seed is available from Minnesota AES, University of Minnesota, St. Paul.

Seventeen alfalfa populations were developed from the BIC (Beltsville International Composite) germplasm pool in individual selection programs (*2*). The BIC populations provide alfalfa breeders with the first alfalfa population representing a complete array of nonhardy and hardy alfalfa sources in one germplasm pool. Nine subpopulations individually selected for resistance to five diseases, three insects, and one nematode were released along with eight populations representing different generations of development. These 17 populations should be valuable for basic research and variety development.

The BIC population was developed in 1965 at Beltsville, Md., from diverse sources of germplasm. Generations 1 and 2 were produced by making 2,400 hand crosses among the 75 sources. Generation 3 (BIC-3) was produced on a 1/3-acre field by the Waterman-Loomis Company at Bakersfield, Calif. Generation 4 (BIC-4) was produced under cage at Reno, Nev. Generation 5 (BIC-5) was produced from 5,000 seedling plants in isolation at St. Paul. These plants were allowed to overwinter, and seed was produced on the surviving 2,000 plants (BIC-5WH). This was the first time conscious selection was practiced in the germplasm pool. One cycle of selection for resistance was conducted in BIC-5 for: Anthracnose (BIC-5-AN) at Beltsville, Md.; bacterial wilt (BIC-5-BW), common leafspot (BIC-5-CLS), field leafspots (BIC-5-FLS), and Phytophthora root rot (BIC-5-PRR) at St. Paul; potato leafhopper (BIC-5-PLH) at Lincoln, Nebr.; pea aphid (BIC-5-PA) and spotted alfalfa aphid (BIC-5-SAA) at Manhattan; and stem nematode (BIC-5-SN) at Reno. Significant increases in resistance were made for all types of selection. Syn 1 seed was produced by hand pollination in the greenhouse. Syn 2 seed for each of the nine pest resistant BIC-5 subpopulations was produced under cage in Fresno, Calif. BIC-6 and BIC-6WH populations were produced at Prosser, Wash. by intercrossing all plants selected for the nine types of pest resistance from BIC-5 and BIC-5-WH, respectively. BIC-7 and BIC-7WH were one-acre increases, at Prosser, of BIC-6 and BIC-6WH, respectively.

NEBRASKA: Contact W. R. Kehr, USDA, SEA, Department of Agronomy, Univesity of Nebraska, Lincoln, Nebr. 68503.

N.S. 16: Developed by the SEA in cooperation with the Nebraska AES, University of Nebraska, Lincoln (*33*). N.S. 16 is a four-clone synthetic segregating for resistance to Stemphylium leaf spot, rust, and potato leafhopper (*Empoasca fabae*) yellowing. It is similar or slightly superior to 'Ranger' in forage yield and bacterial wilt resistance. In greenhouse tests, N.S. 16 had a low level of resistance to Leptosphaerulina leaf spot. It is susceptible to spotted alfalfa aphid (*Therioaphis maculata*) and pea aphid (*Acyrthosiphon pisum*). N.S. 16 has slightly higher carotene and protein contents than 'Ranger'. It is variable for growth habit and other characteristics. Parentage traces principally to 'Atlantic', 'Hardigan', 'Kansas Common', 'Ladak', 'Ranger', and 'Turkistan'.

N.S. 30: Developed by the SEA in cooperation with the Nebraska AES, University of Nebraska, Lincoln (*34*). N.S. 30 is an 11-clone alfalfa synthetic of broad germplasm origin, containing plants with a high level of resistance to potato leafhopper (*Empoasca fabae*) yellowing. It is similar to 'Ranger' in forage yeild. Parentage traces to 'Buffalo', 'Grimm', 'Kansas Common', 'Ladak', 'Turkistan', selections from *Medicago falcata* and glutinosa, and four plant introductions of *M. sativa*: P.I. 107298 Turkey, P.I. 204889 Turkey, P.I. 206278 Turkey, and P.I. 243224 Iran. N.S. 30 is variable for resistance to bacterial wilt, growth habit, and other characteristics.

NC-83-1 and NC-83-2: Developed by the SEA; the Nebraska, Minnesota, Kansas, Illinois, Iowa, Indiana, South Dakota, Alaska, and Wisconsin AES; and Arnold-Thomas Seed Service and Felco Land O'Lakes, Inc. Seed is available through the Nebraska AES, University of Nebraska, Lincoln, Nebr. (*35*).

Two alfalfa germplasm pools, NC-83-1 and 2, were developed by the members of the NC-83 Regional Research Project (1) to provide broad-based populations to be used as sources of disease, insect, and stem nematode resistance plus desirable agronomic traits for alfalfa improvement programs; (2) to provide plant breeders with large quantities of seed from which to select for favorable combinations of traits; and (3) to preserve germplasm.

NC-83-1 has two main sources of parental germplasm. Source I contained 94 cultivars, experimental synthetics, breeding populations, and released germplasms adapted to the northern alfalfa growing areas of the United States. Most of these entries had resistance to one or more important pests. Source II consisted of 36 foreign plant introductions that had some resistance to one or more important pests. These introductions were all winter hardy.

Entries in source I included the following cultivars:

Agate	Iroquois	Roamer	Weevlchek
Anchor	Kanza	Saranac	WL210
Apalachee	Ladak 65	Scout	WL215
Apex	Lahontan	Superstan	WL305
ATRA 55	Nomad	Team	WL306
Atlantic	Norseman	Teton	WL308
Cossack	Orca	Titan	520
Culver	Orenberg	Thor	522
Dawson	Rambler	Travois	530
Delta	Ramsey	Vernal	
Dominor	Ranger	Warrior	
Drylander	Rhizoma	Washoe	

Other source I components were:

Alaska Syn A, Syn B, and Syn C from the Alaska AES and SEA; Ill. #1, Ill. #2, Ill. E6-69, and Ill. E7-69 from the Illinois AES; Kan. 69-2330, Kan. 99-2549, Kan. 99-2591, Kan. 99-2649, Kan. 99-2651, KS10, KS11, KS16, KS18, KS21, and KS41 from the Kansas AES and SEA; Minn. Syn K, MnC-1, MnP-B1, 20DRC-Seg., 1292-Seg., and a selected Ladak population from the Minnesota AES and SEA; Neb. 69-6509, Neb. 69-6801, Neb. 99-6853, Neb. 99-6875, Neb. 99-6991, Neb. 99-7000, N.S. 16, N.S. 21, N.S. 30, N.S. 40, N.S. 49, N.S. 59, and N.S. 60 from the Nebraska AES and SEA; ARS Syn 2, AWPX3, Belts. 1-An4, Belts. 2-An4, Belts. 3-An4, MSA CW_3 An_3, MSB CW_5 AN_3, MSE_6, MSF_6, U-5156, and U-5157 germplasm releases from SEA; and WEV from the Wisconsin AES.

Entries in source II, received from the Regional Plant Introduction Station, Ames, Iowa, included the following plant introductions (PI numbers):

170543	211054	220668	239953
173728	211608	220808	243223
175789	212105	222112	246356
182240	212861	228152	250779
199275	217419	229570	250936
201864	219928	234205	253951
204591	220298	234673	258830
206572	220299	237723	262538
210763	220301	239950	279958

In the spring of 1972, seeds of all 130 entries were sowed separately in the greenhouse at Caldwell, Idaho. Seedlings were transplanted to the field in a modified split-plot design and spaced approximately 0.6 m between rows. The total populations of about 9,200 plants consisted of about 90 plants per entry from source II (8 percent of the pool). About 5 percent of the plants did not produce seeds. Harmful insects were controlled, and no disease problems were evident. Only limited isolation was available. Leafcutter bees, *Megachile rotundata* F., were used for pollination. A handful of pods was harvested from each plant by carefully stripping pods from the bottom to the top of one or more stems. All pods were bulked and threshed. No selection was practiced during production of cycle 1 seed.

The hand-harvested bulk of NC-83-1 cycle 1 seed produced in 1972 was seeded in the spring of 1973 at a rate of 2.2 kg/ha in a 0.4-ha field at Caldwell, Idaho. NC-83-1 cycle 2 seed was produced in 1973 under limited isolation and harvested in bulk.

NC-83-2 has two main sources of parental germplasm. Source I included 63 cultivars, experimental synthetics, breeding populations, and released germplasms adapted to the southern part of the north central region of the United States. Most of these entries had resistance to one or more important pests. Source II consisted of 45 foreign plant introductions that had some resistance to one or more important pests.

Entries in source I included the cultivars:

Agate	Dawson	Ranger	Warrior
Anchor	Delta	Saranac	Washoe
Apalachee	Dominor	Scout	Williamsburg
Apex	Florida 66	Stride	WL306
AS49	Kanza	Team	WL308
Atlantic	Lahontan	Tempo	WL508
Buffalo	Mesilla	Thor	525
Cody	Orca	Uinta	153

Other source I entries were:

Ind. Syn C from the Purdue AES; Ill. #1, Ill. #2, Ill. E6-69, and Ill. E7-69 from the Illinois AES: Kan. 69-2330, Kan. 99-2549, Kan. 99-2691, Kan. 99-2649, Kan. 99-2651, KS10, KS11, KS16, KS18, KS21, and KS41 from the Kansas AES and SEA; 20DRC Seg., 1292 Seg., and MnP-B1 from the Minnesota AES and SEA; N.S. 16, N.S. 21, N.S. 30, N.S. 49, and N.S. 59 from the Nebraska AES and SEA; and ARS Syn 2, Belts. 1-An4, Belts. 2-An4, MSA CW_3 An_3, MSB CW_5 AN_3, MSE_6, and MSF_6 germplasm releases from SEA.

Entries in source II included the following plant introductions (PI numbers):

141462	205329	220298	235736
170543	205634	220299	239950
173728	206572	220301	239953
175789	209090	220668	243223
182240	210763	220808	243224
183262	211054	222112	250779
183404	211608	227851	250936
190259	212105	229570	253951
199275	212861	234205	258817
201864	217419	234443	262538
202824	219928	234673	279958
204591			

NEVADA: Contact O. J. Hunt, USDA, SEA, Division of Plant, Soil, and Water Science, University of Nevada, Reno, Nev. 89557.

MSE6 and MSF6: Developed by the SEA in cooperation with the Arizona and Nevada AES; SEA, Forage Insects Laboratory, Tucson, Ariz.; and University of Nevada, Reno, Nev., respectively (*32*). MSE6 and MSF6 are vigorous populations with broad genetic bases tracing to cultivars 'Turkistan' and 'Flammande', and experimental populations MSA9 and MSB9. They are highly resistant to the pea aphid and to biotypes ENT-A and ENT-B of the spotted alfalfa aphid, and moderately resistant to bacterial wilt and stem nematodes. MSE6 and MSF6 have undergone six cycles of recombination. Selection was practiced only in the last three cycles to minimize undesirable gene shifts associated with linkage effects.

Cycles 0-4: MSE originated from intercrossing 50 plants of Nevada Syn K, 10 of 'DuPuits', and 40 of MSA9. MSF originated from intercrossing 50 plants of 'Lahontan', 10 of 'DuPuits', and 40 of MSB9. Nevada Syn K is a four-clone synthetic with high resistance to spotted alfalfa aphid, stem nematode, bacterial wilt, and some resistance to pea aphid. Nevada Syn K traces to 'Nemastan'. MSA9 and MSB9 were described by Dudley et al. (*16*).

About 300 Syn 1 plants were intercrossed within each pool to initiate cycle 2. In cycles 2 and 3, 80 plants were intercrossed within pools to form the next cycle. Some plants were selected for resistance to foliar diseases and leafhopper yellowing in cycle 4. Initial crossing and cycles 1 to 4 were accomplished at Beltsville, Md., from 1959 to 1963.

Cycle 5: In 1964 at Reno, 10,000 seedlings of each pool in cycle 4 were infested with spotted alfalfa aphids in field cages. We inoculated 790 resistant selections from MSE and 663 from MSF with bacterial wilt and then subjected these selections to pea aphid infestation. Selection reduced MSE Numbers to 100 and MSF numbers to 65. Resistant selections were intercrossed within pools.

Cycle 6: In 1966, seedlings of each population in cycle 5 were screened for pea aphid resistance at Tucson, Ariz. Pea aphid resistant selections were then rated individually for resistance to biotype ENT-A of the spotted alfalfa aphid. In 1967, 136 MSE and 145 MSF selections resistant to both aphids were intercrossed within pools at Reno.

Aphid tests: In three tests of MSE6 and MSF6 with biotype ENT-A of the spotted alfalfa aphid, conducted in 1968 at Tucson, seedling survival averaged 95.2 and 91.5 percent, respectively. Seedling survival of MSE6 and MSF6 following pea aphid infestation was 92.3 and 99.0 percent, respectively (*31*).

NEVADA Syn XX: Developed by the SEA in cooperation with the California, Nevada, Oregon, Utah, and Washington AES. Seed is available through the Nevada AES, University of Nevada, Reno (*42*). Nevada Synthetic XX (Syn 2) alfalfa was highly resistant to three regional collections of the northern root-knot nematode in greenhouse tests at Reno, and Prosser, Wash. Plants in the susceptible variety 'Lahontan' were heavily galled. At Manteca, Calif., where root-knot nematodes as well as other nematode species were prevalent, Nevada Synthetic XX ranked higher for stand density after 2 years of production than the other 34 cultivars. Stands of many entries were virtually eliminated.

Nevada Synthetic XX was developed by backcrossing root-knot nematode resistant clones M-7 (selected from 'Vernal' by E. H. Stanford) and 1-167 (selected from 'Vernal' by H. L. Carnahan) to clones 609, 466, 552, 1-113, 694 (parents of 'Washoe') C89 (a parent of 'Lahontan'), Nevada 759, and a pea aphid resistant clone (PAR) (*30*). Both donor parents were simplex for the *M. hapla* resistance gene. Test crosses were utilized during backcrossing to identify the genotypes of the resistant progeny. Nevada Synthetic XX is made up of 25 S_1 clones, which are either triplex of quadruplex resistant to *M. hapla*. The Syn 2 generation, which was grown under strict isolation at Reno, is being released. Resistance screening was done with three regional nematode collections from Oregon, Washington, and Utah. Alfalfa seedling survival, in tests conducted under severe spotted alfalfa aphid infestation at Tucson, showed 75.5 and 68.2 percent of Nevada Synthetic XX plants surviving from infestations with biotypes ENT A and ENT F, respectively, compared with 85.3 and 84.3 percent of 'Washoe' plants. Survival under pea aphid attack was 87.2 percent in Nevada Synthetic XX compared with 65 percent in 'Washoe'. Percent of plants resistant to stem nematode (*Ditylenchus dipsaci*) was 71 percent in Nevada Synthetic XX compared with 74 percent in 'Lahontan' in tests at Reno. Bacterial wilt resistance and winter hardiness of Nevada Synthetic XX is expected to be comparable with those of 'Washoe'.

Forage yield tests of Nevada Synthetic XX (Syn 2) have not been completed; however, two experimental synthetics developed and tested during the same backcross program have yielded well. One represented random resistant clones at the duplex level (Synthetic WW) and the other (Synthetic TT) represented some of the parent clones of the S_1 progeny making up Nevada Synthetic XX. Synthetic WW was the highest yielding entry in a 3-year test of 22 cultivars and experimental lines in Salt Lake County, Utah, and one of the highest yielding entries in a 4-year

test in the Columbia Basin of Washington. Synthetic TT ranked second in yield among 36 entries in a 3-year yield test at Reno.

Nevada Synthetic XX is being made available to (1) provide germplasm for the development of multiple pest resistant cultivars, (2) determine the effect of root-knot nematodes on alfalfa yield and persistence, and (3) test the feasibility of using a resistant crop in a rotation to reduce namatode populations.

Nevada MP-9: Nevada MP-9 is a hardy, northern root-knot nematode (*Meloidogyne hapla*) resistant alfalfa population developed by USDA, SEA, in cooperation with the Nevada AES. Nevada MP-9 was highly resistant to three regional collections of the northern root-knot nematode in greenhouse tests at Reno. Nevada MP-9 had 80 percent resistant plants compared with 100 percent resistant plants in Nevada Syn XX and 4.5 percent for 'Lahontan', both semihardy varieties. Nevada MP-9 had 31.9 percent resistant plants and an average severity index of (ASI) 2.48 compared with 38.2 and 2.14 for 'Vernal' in the 1976 Minnesota bacterial wilt variety evaluation study. The 1976 Phytophthora root rot evaluation at Minnesota showed 3.8 percent resistant plants and ASI of 4.03 for Nevada MP-9 compared with 34.0 and 2.87 for 'Agate'.

Nevada MP-9 was developed by phenotypic recurrent selection in several hardy cultivars under heavy root-knot nematode infestations. Root-knot resistant selections from the cultivars '123' (90 selections), 'Vernal' (60 selections), 'WL210' (35 selections), '525' (17 selections), 'WL214' (14 selections), 'Progress' (12 selections), and 'Scout' (5 selections) were intercrossed by honeybees under cage isolation at Reno in 1975. In addition to a high level of root-knot resistance, Nevada MP-9 should possess a gene frequency for resistance to bacterial wilt, spotted alfalfa aphid, pea aphid, common leafspot, and potato leafhopper yellowing of sufficient magnitude to make limited selection for these traits highly productive.

Nevada MP-9 is being made available to (1) provide hardy germplasm for the development of multiple pest resistant cultivars, (2) provide a means for determining the effect of root-knot nematodes on alfalfa yields and persistence in the hardy alfalfa growing areas, and (3) provide a base for developing hardy cultivars with near immunity to root-knot for use in rotation experiments for nematode control.

NMP-8 and NMP-10: NMP-8 was developed using phenotypic reccurent selection for southern anthracnose (*Colletotrichum trifolii* Bain) and Phytophthora root rot (*Phytophthora megasperma* Drechs) resistance in SW_{32}, a modified 'Moapa' alfalfa and Arizona Ron PX. Three cycles of selection for southern anthracnose resistance, including three recombination cycles, followed by two cycles of selection for Phytophthora root rot resistance, which included two recombination cycles, were used to develop NMP-8. Plants were selected during the seedling stage for southern anthracnose resistance in a greenhouse at Beltsville. Phytophthora root rot resistant plants were selected in a Phytophthora field nursery at St. Paul, Minn. Recombination cycles were produced in isolation cages with bee pollination at Reno.

NMP-10 alfalfa was developed parallel to NMP-8 except the parent source of germplasm included 10 southern anthracnose resistant plants from SW17, 58 from SW29, 31 from Experimental 47 (California), 10 from N1412 OP, 44 from El Unico, and 10 from SW17 Syn 1.

NMP-8 and NMP-10 alfalfa have high resistance to anthracnose with 47- and 46-percent resistant plants in a test at Reno, where 'ARC' and 'Saranac' had 65- and 9-percent resistant plants, respectively. Anthracnose evaluation tests at Beltsville (*14*) indicate that anthracnose resistance levels in NMP-8, NMP-10, 'Arc', and 'Saranac' were 46.7, 50.9, 83.0 and 2.1 percent, respectively. In Minnesota, Phytophthora evaluations, NMP-8 showed 33- and NMP-10 74-percent resistant plants with 42 percent in 'Agate' and 1.6 percent in 'Saranac'. Tests indicate that bacterial wilt [*Corynebacterium insidiosum* (McCull.) H. L. Jens.] resistance is comparatively low in NMP-8 and NMP-10. In a Minnesota bacterial wilt evaluation, 'Vernal' exhibited 46.3-percent resistant plants while 'Narragansett', NMP-8, and NMP-10 had 2.3-, 3.5-, and 2.2-percent resistant plants, respectively. NMP-8 had 60-percent resistant plants and an ASI of 1.43 in the 1975 Minnesota Fusarium wilt evaluations.

MSE_6 SN_3 W_3 and MSF_6 SN_3 W_3: Both lines were developed from two cycles of phenotypic recurrent selection for resistance to each pathogen from previously released germplasm MSE_6 and MSF_6 (*31*). Recombination of populations from the first and second cycle of selection for resistance to stem nematode was made with 482 and 174 plants of MSE_6 and 252 and 153 plants of MSF_6, respectively. Recombinant populations for resistance to bacterial wilt from the second cycle of selection consisted of 182 plants of MSE_6 and 162 plants of MSF_6. Recombinant populations from stem nematode tests conducted in greenhouses were intercrossed by honeybees in outdoor isolation cages; whereas, those from bacterial wilt tests conducted in the field were intercrossed by hand in the greenhouses.

In stem nematode tests at Reno, MSE_6 SN_3 W_3 and MSF_6 SN_3 W_3 had 65- and 73-percent resistant plants, respectively, from the second cycle of selection compared with 19-percent resistance in both MSE_6 and MSF_6 populations from the first cycle. Only grade 1 plants were utilized in the final intercross. Resistance to stem nematode in check cultivars was 68 percent for 'Washoe' (resistant) and 8 percent for 'Ranger' (susceptible). In bacterial wilt tests at St. Paul, MSE_6 SN_3 W_3 and MSF_6 SN_3 W_3 had 36- and 57-percent resistant plants, respectively, from the second cycle of selection compared with 4 and 7 percent in the original MSE_6 and MSF_6 germplasm, and 27 and 1 percent in check varieties 'Vernal' (resistant) and 'Narragansett' (susceptible). This germplasm has resistance to pea aphid and spotted alfalfa aphid as described in the original MSE_6 and MSF_6 populations. In addition, reaction to *Phytophthora megasperma* Drechs. was 7-, 13-, 18-, and 0-percent resistant plants for MSE_6 SN_3 W_3, MSF_6 SN_3 W_3, 'Lahontan' (resistant check), and 'DuPuits' (susceptible check), respectively. Although the percentages of resistant plants were not especially high in either population, those plants appeared to be highly resistant.

Nevada Syn YY: Developed by crossing root-knot nematode resistant clones M-7 (selected from 'Vernal' by E. H. Stanford) and 1-167 (selected from 'Vernal' by H. L. Carnahan and R. N. Peaden) to clones C-904, C-906, and C-937 (parents of 'Moapa 69'), and two spotted alfalfa aphid and pea aphid resistant selections from 'Moapa', N-1368, and N-1548. Three backcrosses to the nonhardy clones followed the initial crosses to maintain the characteristics of the nonhardy type as well as resistance to *M. incognita* and *M. javanica*. At the end of three backcross generations, simplex resistant *M. hapla* clones were selfed to produce duplex individuals. Selected duplex individuals were sibbed to produce simplex, duplex, triplex, and quadruplex resistant individuals. Resistant clones from the sib generation were test crossed to a susceptible (nulliplex) clone, and

parents with nonsegregating progeny were considered triplex or quadruplex. Forty triplex and quadruplex *M. hapla* resistant clones (determined by one test cross) were selected and intercrossed by honeybees in an isolation cage. Seed produced from each plant was kept separate and tested for segregation for *M. hapla* resistance in a greenhouse. Twenty-one of the 40 clones were discarded; whereas, the remaining 19 clones, which showed no segregation, were intercrossed by honeybees in an isolation cage, producing Syn 1 seed. One cycle of phenotypic recurrent selection for resistance to *M. incognita* on Syn 1 seed at Reno was followed by an additional cycle of selection at the University of California, Riverside.

Forage yield tests and disease evaluations of Nevada Syn YY have not been completed; however, it is well adapted to nonhardy areas and should be of special value where soils are heavily infested with root-knot nematode. Tests for resistance to *M. incognita* and *M. hapla* indicated that at least 95 percent of the plants in Nevada Syn YY were resistant to both nematodes.

Nevada Syn YY is being made available to (1) provide germplasm for the development of multiple pest resistant cultivars, (2) determine the effect of root-knot nematodes on alfalfa yield and persistence in nonhardy areas, and (3) test the feasibility of using a resistant crop in rotation to reduce nematode populations.

Washington Stem Nematode Intercross (SNI): Developed from a composite of two anthracnose (*Colletrotrichum trifolii* Bain), two Phytophthora root rot (*Phytophthora megasperma* Drechs.), and 10 stem nematode [*Ditylenchus dipsaci* (Kühn) Filipjev] resistant alfalfa lines. Southern anthracnose resistant lines were Saranac An_4 and Vernal An_4. Phytophthora root rot resistant lines were Mn PC_3 and Mn PA_3. Stem nematode resistant lines were WA-S-3 ('Team'), WC-S-3 (Nevada Syn Y), WD-S-3 ('Vernal'), WE-S-3 (Nevada Syn WW), WF-S-3 ('Williamsburg'), WG-S-3 ('Talent'), WH-S-3 (P.I. 141462 'Iranian'), WI-S-3 ('Lahontan'); WN-S-1 (P.I. 279958 'Turkish'), and WR-S-1 ('Nematol I').

Parental lines were seeded in replicated long rows, spaced one foot apart, in an intercross isolation cage and maintained in equal maternal proportion for two additional generations of recombination. One cycle of phenotypic selection for stem nematode resistance was conducted after the second cycle of recombination. Approximately 200 stem nematode resistant selections from bulk of the second recombination were intercrossed by honeybees in an isolation cage to produce both Syn 1 and Syn 2 seed.

Washington SNI Syn 2 had 64-percent stem nematode resistant plants in a replicated evaluated test at Reno compared with 64 percent for 'Washoe' and 10 percent for 'Ranger'. University of Minnesota bacterial wilt [*Corynebacterium insidiosum* (McCull.) H. L. Jens.] evaluation tests indicated that 31-percent of Washington SNI plants were resistant compared with 38 percent in 'Vernal' and 16 percent in 'Ranger'. Tests for anthracnose resistance at Reno indicated that Washington SNI had 10-percent resistant plants compared with 2 percent in Saranac and 61 percent in 'Arc'. Phytophthora root rot tests at Minnesota showed 10-percent resistant plants in Washington SNI, 34 percent in 'Agate', and 2 percent in 'Saranac'.

NEW YORK: Contact R. P. Murphy, Department of Plant Breeding and Biometry, Cornell University, Ithaca, N. Y. 14850.

Experimental Synthetics: Developed by the New York AES, Cornell University, Ithaca. These unofficial releases include several experimental synthetic cultivars as source germplasm for many diverse characteristics including a multifoliolate line.

NORTH CAROLINA: Contact T. H. Busbice, USDA, SEA, Dpeartment of Crop Science, North Carolina State University, Raleigh, N. C. 27607.

NCW(64)1: Developed by the SEA in cooperation with the North Carolina AES, University of North Carolina, Raleigh. NCW(64)1 is a strain of alfalfa selected for resistance to oviposition (egg laying) of the alfalfa weevil.

The seed lot, NCW(64)1, was produced by intercrossing 11 plants of *Medicago sativa* var. *gaetula* (P.I. 239953 collected in Algeria) selected for resistance to oviposition. Resistance of the *gaetula* strain to egg laying was repeatedly confirmed in greenhouse tests. Eggs recovered from stems of *gaetula* accessions averaged only 4 to 18 percent as many as those from the 'Atlantic' check. Reduction in total eggs produced was correlated with a reduction in the number and size of egg masses and was associated with a decrease in amount of stem pith or an increase in stem solidness. The effectiveness of this type of resistance under field conditions remains to be determined.

The introduction is spreading in growth habit, low in forage production, and, generally, not adapted to hay production in the United States; hence, resistance will need to be transferred to agronomically desirable types. In crossing studies, this strain appeared to be fully interfertile with other forms of *M. sativa*.

NCCr1: Developed by the SEA in cooperation with the North Carolina and Nevada AES. NCCr1 alfalfa was bred from 'Canadian Creeper' and North Carolina breeding stocks by recurrent field selection for the creeping-rooted character and adaptation to North Carolina. A complete description is presented in Crop Science (*8*). In North Carolina, more than 50 percent of the plants of NCCr1 will display the creeping characteristic after 2 years of growth under spaced conditions in the field; however, under dense competition, the frequency of creeping is much less.

NCCr1 is less vigorous than adapted noncreeping varieties. Slow recovery after cutting appears to be the greatest weakness. Because of these characteristics, NCCr1 is not recommended for use as a commercial variety. The greatest value of NCCr1 will be as a parent in strain crosses with other adapted strains. In cross combination with other adapted germplasm, the hybrid populations are quite variable, but generally they display an upright growth habit, a low-set dense crown, a vigorous, branching root system, and a low frequency of the creeping characteristic.

NCW21: Developed by the SEA in cooperation with the North Carolina and Nevada AES. NCW21 alfalfa is vigorous and well adapted to the environment and soils of southeastern United States. It has high resistance to anthracnose (*Colletotrichum trifolii* Bain) with about 75 percent of the plants completely resisting disease development. It has high resistance to pea aphid (*Acyrthosiphon pisum* (Harris)) with 65 percent of the plants showing resistance.

NCW21 has high tolerance to spring defoliation by alfalfa weevil larvae (*Hypera postica* (Gyllenhal)), showing only one-fifth to one-third as much

defoliation as susceptible varieties. NCW21 is related to the cultivars 'Arc', 'Liberty', and 'Team', having been bred from the same genetic stocks; however, NCW21 shows only about two-thirds as much defoliation by weevil larvae as do these varieties. In hybrid combination with susceptible varieties, weevil tolerance is intermediate between the parents.

NCW21 was bred by recurrent field selection for vigorous, healthy plants, which showed tolerance to defoliation by the alfalfa weevil larvae. Anthracnose resistance was bred into the last generation by laboratory selection. Final selection was based on clonal evaluation in the field and laboratory for weevil tolerance and anthracnose resistance, respectively. Twenty clones were randomly mated to produce NCW21.

MARYLAND: Contact J. H. Elgin, Jr., USDA, SEA, Crops Research Laboratory, BARC-West, Beltsville, Md. 20705.

Germplasm Pools A and B: Developed by the SEA, Beltsville, Md., and the U.S. Regional Pasture Laboratory, University Park, Pa., and the North Carolina AES, University of North Carolina, Raleigh, N. C.

Seven germplasm releases from two unrelated broad-based populations of alfalfa (*Medicago sativa* L.) are described. Pools A and B were subjected to 16 recurring cycles of phenotypic selection for disease and insect resistance. Germplasm releases were made at critical stages of genetic improvement in both populations.

Each of the two pools was initiated in 1950 by intercrossing vigorous plants selected from 3- and 4-year-old broadcast stands. Parent plants for pool A consisted of 300 plants from the cultivar 'Atlantic' and 33 plants each from two Kansas synthetics and one Nebraska synthetic. Pool B was initiated with 40 plants each from 'Buffalo', 'Williamsburg', four Kansas synthetics, 'DuPuits', 'Oklahoma Common', and 'Kansas Common'. In each subsequent cycle, 2,000 to 5,000 plants were evaluated in each pool on the basis of phenotype. Usually no fewer than 80 plants were selected for intercrossing within a pool to initiate a new cycle. This program of mass selection was designed to conserve genetic variability for unselected traits, permit genetic recombination, and enhance the probability of isolating multiple pest-resistant individuals that would express heterosis in synthetic and hybrid combinations.

The first eight cycles of selection were conducted in the field at Raleigh, primarily for resistance to leafhopper yellowing, rust, and adaptability (*16*, *27*). B8 was released by the North Carolina AES and the SEA as the cultivar 'Cherokee' (*15*). Three cycles of rigid field selection, for resistance to potato leafhopper yellowing in each pool, were conducted at Beltsville, Md. High levels of resistance to leafhopper yellowing were developed in A-L4 and B-L4, but both are subject to stunting under heavy infestation.

MSA-C4 and MSB-C4: A-L4 and B-L4 were the base populations for three cycles of selection for common leafspot resistance. Inoculation and selection procedures were carried out in growth chambers at the U.S. Regional Pasture Research Laboratory (*22*). MSA-C4 and MSB-C4 were released on November 5, 1965, and were described as vigorous, dark green, and resistant to potato leafhopper yellowing, rust, and common leafspot. They persisted better and were more vigorous than commercial cultivars at Beltsville (*26*). MSA-C4 and MSB-C4 were resistant and

moderately resistant, respectively, to anthracnose. Both populations were susceptible to bacterial wilt, but MSA-C4 contained some resistant plants.

GP3 and 4 (MSA-W4 and MSB-W4): AL4 and BL4 were the base populations for three cycles of selection for bacterial wilt conducted in growth chambers at Beltsville. MSA-W4 and MSB-W4 were released on December 13, 1966, and were described as vigorous, dark green, and resistant to potato leafhopper yellowing and rust. They had some resistance to anthracnose. They also persisted better and were more vigorous than commercial cultivars at Beltsville (*26*). In a field test for resistance to bacterial wilt at St. Paul, ASI scores (on a scale of 0 to 5, 0 = most resistant class) were as follows: MSA-W4 (1.2), MSB-W4 (3.9), 'Vernal' (1.9), 'Ranger' (3.3), and 'Narragansett' (4.4).

GP5 and 6 (MSA-A3 and MSB-A3): A8 and B8 also were the base populations for three cycles of selection for spotted alfalfa aphid resistance. Isolation of resistant plants was done by the SEA at Bakersfield, Calif., and Tucson, Ariz. MSA-A3 and MSB-A3 were released on December 13, 1966, and were described as dark green and resistant to spotted alfalfa aphid (*24*), potato leafhopper yellowing, and rust. They were more persistent than commercial cultivars at Beltsville (*26*). MSB-A3 is very susceptible to bacterial wilt, but MSA-A3 contains some resistant plants. Both MSA-A3 and MSB-A3 were less vigorous than other releases from pools A and B, which was attributed to recombining an insufficient number of plants in the first cycle of aphid selection (*26*).

GP7 (MSA-CW3): A-C4 was the base population for two cycles of bacterial wilt selection in growth chambers at Beltsville. MSA-CW3 was released on March 20, 1968, and was described as vigorous, dark green, and resistant to bacterial wilt, common leafspot, potato leafhopper yellowing, and rust. It was more persistent than commercial cultivars at Beltsville (*26*) and resistant to anthracnose (*26*). In a bacterial wilt field test conducted at St. Paul, ASI scores for MSA-CW3 and three cultivars were as follows: MSA-CW3 (1.3), 'Vernal' (1.8) 'Ranger' (2.5), and 'Narragansett' (4.0) (on a scale of 0 to 5, 0 = no disease symptoms).

AWPX3: Developed by the SEA, Beltsville. AWPX3 had moderate levels of resistance to the alfalfa weevil in laboratory tests to larval development, adult feeding, and forced oviposition. Resistance of AWPX3 to larval development was greater than that of check varieties 'Atlantic', 'Cherokee', 'Vernal', and 'Williamsburg'; resistance to adult feeding was greater than that of 'Cherokee'; and resistance to forced oviposition was greater than that of either 'Cherokee' or 'Atlantic'. In North Carolina tests, AWPX3 did not differ significantly from check varieties in resistance to oviposition preference. AWPX3 appears to be a promising source from which to select individual plants with levels of resistance greater than those indicated above for the population as a whole. Field performance of AWPX3 has not been determined.

AWPX3 is an extremely broad-based population. Parentage traces to 32 clones from 'Atlantic', 'Ladak', *Medicago falcata*, a rhizomatous selection from N59-1736, old Maryland fields unidentified as to variety, and 13 plant introductions (P.I. 202824, P.I. 204461, P.I. 223789, P.I. 233197, P.I. 234442, P.I. 235539, P.I. 235821, P.I. 236606, P.I. 253445, P.I. 258752, P.I. 258829, P.I. 262536, and P.I. 263154).

More than 200,000 plants were initially observed in field and laboratory tests. Promising plants were cloned and subjected to replicated laboratory tests for low adult feeding, oviposition response, and larval development. Thirty-two clones showing resistance for one or more criteria were inter-pollinated with bees under cage at Reno, to produce seed designed as AWPX2. AWPX2 was subjected to three successive screening tests, wherein the most susceptible plants were discarded from each test. The testing sequence included preference feeding of adult weevils at the cotyledon stage, forced feeding of adults on leaf disks, and larval development. The extent to which plants were eliminated at each stage in the series is indicated by the number of plants entering the respective tests; namely, 32,000, 951, and 532. The 163 clones selected for low average larval weight were intercrossed under cage at Reno for the production of AWPX3 seed.

AWPX3 is segregating for winterhardiness and growth type. Nearly one-third of the original clones were from nonhardy sources. AWPX3 was classified as moderately susceptible to bacterial wilt but contained some resistant plants. ASI scores of AWPX2 and checks in a field test at St. Paul were as follows: AWPX2 (3.4), 'Narragansett' (4.0), 'Ranger' (2.5), and 'Vernal' (1.8) (wilt scale 0 to 5, with 0 = most resistant class).

MSB-CW5: MSB-CW5 has high resistance to rust, potato leafhopper yellowing, common leafspot, and a moderate level of resistance to bacterial wilt. It is also more persistent than commercial varieties in eastern tests. The usefulness of this population for a specific environment may be increased by imposing field selection to isolate adapted as well as pest-resistant germplasm.

MSB-CW5 was developed from MSB-C4 (released in 1965) by subjecting the latter to four cycles of selection for resistance to bacterial wilt at Beltsville. In a bacterial wilt test conducted at St. Paul, ASI scores were MSB-CW5 (2.63), 'Vernal' (2.17), 'Ranger' (3.04), and 'Narragansett' (4.46) (on a scale of 0 to 5, with 0 = healthy, 5 = dead).

Previous history of selection: MSB-CW5 is the product of 18 cycles of phenotypic recurrent selection. There were eight cycles of selection at Raleigh, N. C., three at Beltsville, three at the U.S. Regional Pasture Research Laboratory, University Park, Pa., and four (for resistance to bacterial wilt) at Beltsville. Field selection was practiced during all cycles except in the last seven where growth chambers were used. In each cycle, 2,000 to 5,000 plants were examined and 80 to 250 plants were selected and intercrossed to initiate each new cycle. In addition to improvement for the selected characters, this selection procedure was designed to permit maximum genetic recombination, preserve variability for unselected characters, and enhance the breeding value of the improved populations. Additional information on the origin, breeding, and performance of this population can be found in several references (*15*, *16*, *22*, *24*, *26*, and *27*).

Beltsville 1-An4, Beltsville 2-An4, Beltsville 3-An4, Beltsville 4-An2, and Beltsville 5-An2: These five populations were developed jointly by the SEA at Beltsville and the Nevada AES. The three populations Beltsville 1-An4 through Beltsville 3-An4 have high resistance to southern anthracnose. The usefulness of these populations for a specific environment may be increased by imposing field selection to isolate adapted as well as anthracnose-resistant germplasm.

Beltsville 1-An4, Beltsville 2-An4, and Betsville 3-An4 trace to the cultivars 'Glacier', 'Saranac', and 'Vernal', respectively, and were developed by three cycles of phenotypic recurrent selection in the laboratory and greenhouse at Beltsville (*12*, *13*). Beltsville 4-An2 was developed by one cycle of similar phenotypic selection in five Mexican introductions: P.I. 343050, P.I. 343051, P.I. 343052, P.I. 343053, and P.I. 343054. Beltsville 5-An2 was developed by one cycle of phenotypic selection in the cultivar 'Hairy Peruvian', the Peruvian ecotypes 'Ioro' (P.I. 355878), 'Macate' (P.I. 355880, 'Ocurunga' (P.I. 355882), 'Yaragua' (P.I. 355885), and a Spanish introduction 'San Isidro' (P.I. 315351). In each cycle and population, from 4,000 to 8,000 plants were inoculated with anthracnose. From 110 to 300 plants were intercrossed in each cycle to initiate the next cycle. In addition to developing resistance to anthracnose, this selection procedure was designed to permit maximum genetic recombination, preserve variability for unselected characteristics, and enhance the breeding value of these populations. Levels of anthracnose resistance of the selected populations compared with check cultivars are shown in table 5.

MSA CW_3 AN_3 and MSB CW_5 AN_3: MSA CW_3 AN_3 and MSB CW_5 AN_3 (*25*) are broad-based alfalfa germplasm pools, which are resistant to anthracnose, bacterial wilt, common leafspot, potato leafhopper yellowing, and rust. The usefulness of these populations for a specific environment may be increased by imposing field selection to isolate adapted as well as pest resistant germplasm.

MSA CW_3 AN_3 was developed during 1969-70 by subjecting MSA CW_3 (released in 1968) to two cycles of phenotypic selection for resistanct to anthracnose in the laboratory and greenhouse at Beltsville. Similarly, MSB CW_5 AN_3 was developed from MSB CW_5 (presently being released). The anthracnose resistance of resulting populations is shown in table 6 in comparison with a susceptible cultivar.

Previous history of development for other characteristics: MSA "CW_3" AN_3 and MSB CW AN_3 underwent 18 and 20 cycles of recurrent phenotypic selection, respectively. MSA CW_3 AN_3 resulted from eight cycles of selection at Raleigh; three at Beltsville; three at the U.S. Regional Pasture Research Laboratory, University Park, Pa., and four again at Beltsville. An identical program of selection was used to develop MSB CW_5 AN_3 except that there were six instead of four cycles in the final phase of selection at Beltsville. Field selection was practiced during all cycles except in the last seven and nine cycles of the respective populations, where growth chambers were used. In each cycle, 2,000 to 5,000 plants were examined. Eighty to 260 plants were selected and intercrossed to initiate each new cycle. In addition to improvement for specific characters, this selection was designed to permit maximum genetic recombination, preserve variability for unselected characters, and enhance breeding value. Seed increases of these populations were made at Reno.

Additional information on the origin, breeding, and performance of these populations can be found in several references (*15*, *16*, *22*, *24*, *26*, and *27*).

DA-1 and DA-2: DA-1 traces to 'Moapa', Beltsville 2-An_4W_2, and Arc-Sb3W2F1. DA-2 traces to Florida 66, Beltsville 2-An_4W_2, and Arc-Sb3W2F1. DA-1 was developed by selecting 86 plants of 'Moapa', which had survived two winters in broadcast plots at Beltsville, and crossing them to an equal number of plants of each of Beltsville 2-An_4W_2, and Arc-Sb3W2F1. Progeny of these crosses were carried through two additional cycles of genetic recombination to produce DA-1. To preserve genetic variation, over 280 plants were intercrossed in each cycle. In a parallel manner, DA-2 was developed by selecting 100 vigorous plants of Florida

66, which survived two winters in broadcast plots at Wye Hills, Md., and crossing them to an equal number of plants of each of Beltsville $2\text{-}An_4W_2$, and Arc-Sb3W2F1. The progeny population thus generated was subjected to two cycles of genetic recombination to produce DA-2. Over 290 plants were intercrossed in each cycle. These populations are released to provide alfalfa breeders with anthracnose resistant germplasm from which they may select alfalfas with a reduced level of dormancy and higher yield potential, and resistance to the spotted alfalfa aphid as well as other desirable characteristics.

TABLE 5.--*Frequency distribution of plants in resistant classes and mean score for anthracnose resistance of selected alfalfa populations and check cultivars*

Population or cultivar	Percentage of plants in score classes[1]					Mean score
	1	2	3	4	5	
			Test 1			
Beltsville 1-An4	82	3	1	8	5	1.53
Beltsville 2-An4	72	6	9	13	1	1.66
Beltsville 3-An4	59	11	10	19	1	1.92
Glacier	5	1	2	59	33	4.15
Saranac	5	1	1	66	28	4.13
Vernal	1	0	3	52	44	4.42
LSD (.05)						.34
			Test 2			
Beltsville 4-An2	26	21	22	29	2	2.56
Beltsville 5-An2	35	13	24	24	4	2.50
Saranac	1	0	1	35	63	4.60
LSD (.05)						.54
			Test 3			
Beltsville 4-An2	35	14	16	33	3	2.54
Beltsville 5-An2	31	20	16	27	6	2.54
Saranac	4	2	2	61	31	4.15
LSD(.05)						.35

[1]Scored 1 to 5: 1 = highly resistant, 5 = dead plant.

TABLE 6.--*Frequency distribution of plants in resistant classes and mean score for anthracnose resistance of MSA CW_3 AN_3, MSB CW_5 AN_3, and a susceptible check cultivar*

Population or cultivar	Percentage of plants in score classes[1]					Mean score
	1	2	3	4	5	
			Test 1			
MSA CW_3 AN_3	87	2	2	8	1	1.34
MSB CW_5 AN_3	80	2	2	14	2	1.53
Saranac	4	2	2	61	31	4.15
LSD (.05)						.35
			Test 2			
MSA CW_3 AN_3	80	0	1	16	3	1.66
MSB CW_5 AN_3	88	2	2	8	0	1.30
Saranac	1	0	1	35	63	4.60
LSD (.05)						.54

[1]Scored 1 to 5: 1 = highly resistant, 5 = dead plant.

DA-1 and DA-2 have been characterized at Tucson for resistance to the pea aphid and the spotted alfalfa aphid. DA-1 is highly resistant and DA-2 is moderately resistant to the pea aphid. Both populations had 8- to 9-percent seedling survival in tests with biotype H of the spotted alfalfa aphid. DA-1 and DA-2 have been characterized as moderately resistant to anthracnose by the agar plate test.

Resistance to bacterial wilt and Phytophthora root rot are described in the Minnesota test data presented in table 7.

Beltsville 72: Beltsville 72 is highly resistant to anthracnose and bacterial wilt and moderately resistant to Phytophthora root rot and stem nematode.

Beltsville 72 traces to the cultivar 'Saranac' and was developed from Beltsville 2-An4, released in 1970, by one cycle of intense recurrent phenotypic selection for bacterial wilt resistance in the greenhouse at Beltsville. Approximately 3,500-month-old plants were inoculated with the bacterial wilt organism by the root-soak technique. To produce the Syn 1, 800 resistant plants were intercrossed in the greenhouse. Syn 2 seed production of Beltsville 72 was obtained at Prosser, Wash., in 1972 and 1973.

TABLE 7.--*Resistance to bacterial wilt and Phytophthora root rot in alfalfa cultivars and experimentals DA-1 and DA-2*

Entry	Bacterial wilt		Phytophthora root rot	
	Percent Resistant Plants	Average Severity Index	Percent Resistant Plants	Average Severity Index
Release Populations				
DA-1	15.1	3.04	0	4.70
DA-2	21.4	2.88	.6	4.65
Check Cultivars				
Narragansett	.9	4.01	-	-
Ranger	17.9	2.79	-	-
Vernal	34.1	2.30	-	-
Saranac	-	-	0	5.47
Agate	-	-	19.0	3.35

The merits of Beltsville 72 are highlighted in table 8. High resistance to anthracnose and bacterial wilt and moderate resistance to Phytophthora root rot and stem nematode have been demonstrated. In forage yield trials, first- and second-year production of Beltsville 72 in Pennsylvania, New York, Connecticut, and Washington were equal to or higher than that of 'Saranac'.

TABLE 8.--*Percent resistant plants of Beltsville 72 and check entries for anthracnose, bacterial wilt, Phytophthora root rot, and stem nematode*

Entry	Percent resistant plants[1]			
	Anthracnose	Bacterial wilt	Phytophthora	Stem nematode
Beltsville 72	78	52	19	49
Saranac	1	37	2	32
Agate	--	--	47	--
Vernal	--	35	--	18
Lahontan	--	--	--	68

[1]Anthracnose data from Beltsville evaluations, bacterial wilt and Phytophthora data from Minnesota evaluations, and stem nematode data from Washington evaluations. Dashes indicate no data.

ONTARIO, CANADA: Contact W. R. Childers, Ottawa Research Station, Central Experimental Farm, Ottawa, Ontario, Canada K1A0C6.

Seed Stocks: Yellow Cotyledon; Chlorophyll Deficient (X_1)(*9*), a mutant with yellow cotyledons and yellow leaves. Seedlings that manage to live to maturity are dwarfs. The character is determined by a single recessive gene (Xantha-1 or X_1) inherited tetrasomically. A histological study of the leaf morphology indicates that tissues of the leaves of mutant plants have structures similar to those of green leaves. Plastids are well formed but take up stain weakly in comparison with the plastids in normal green leaves.

Branching Inflorescence: This genetic trait is characterized by the branched-racemes and normal floral parts among S_1 progeny. The trait was traced to the alfalfa cultivar 'Flammande'. The pedicels normally produce one floret on alfalfa; however, on the branched raceme, the pedicels are much longer and each produce a cluster of from three to seven florets. Plant growth is normal until the atypical flower traits develop. Seed production is normal. The trait is controlled by a single recessive gene (br_1) inherited in a tetrasomic manner.

Seed Stocks: Contact L. Dessureaux, Ottawa Research Station, Central Experimental Farm, Ottawa, Ontario, Canada K1A0C6.

Chlorophyll Deficient Mutants (11): A genetic mutant characterized by yellow cotyledons. Seedling mortality usually occurs in those plants expressing the character. The yellow cotyledon trait is controlled by four genes inherited in a tetrasomic manner. The multiplex condition of each gene produced yellow cotyledons. Phenotypes were similar to the Xantha-1 (X_1) described by Childers above. The four genes were designated X_2, X_3, X_4, and X_5. Evidence suggests a linkage between the X_2 and X_3 genes. The following seed stocks are released for distribution:

X_2 Chlorophyll deficiencies 445-36, duplex and simplex

X_3 445-36-6, duplex and simplex

X_4 54-1136-16, duplex and simplex

X_5 Rhizoma 4, duplex and simplex

X_6 D D_4, 44-2-24, duplex

X_7 AT 183, duplex

X_8 M3, duplex

X_9 AT 115, duplex

X_9 AT 115-90, simplex

X_{10} E20, duplex

X_{11} E51, duplex

X_{12} L21, duplex

X_{13} L36, duplex

X_{14} L91, duplex

X_{16} E70, duplex

AT-1 through AT-8: Eight lines of alfalfa that are tolerant to acid soils.

A-1 and A-2: Two lines of alfalfa that are tolerant to aluminum toxicity.

MT-1, MT-2, and MT-5: Three lines tolerant to manganese toxicity.

ZL-1 through ZL-40: 40 lines of alfalfa, characterized by pleiocotyly (multiple cotyledons), that have been selfed and crossed.

Syn CR-1: A creeping rooted synthetic variety.

Syn TC-2: A synthetic variety developed for ability to tolerate frequent defoliation.

SASKATCHEWAN, CANADA: Contact D. H. Heinrichs, Head, Forage Production and Utilization, Agriculture Canada, Research Station, Swift Current, Saskatchewan, Canada S9H3XZ.

SC Syn 3651: A yellow-flowered alfalfa, *Medicago media* Pers., developed at the Research Station, Canada Department of Agriculture, Swift Current, Saskatchewan. It is well adapted for pasture and hay production on dry land in the open plains region of western Canada. Subsequently released and licensed in Canada as the cultivar 'Drylander'.

SC Syn 3601: A synthetic cultivar made up of 34 selections from populations of intercrosses between vigorous 'Lahontan' plants and Swift Current creepers. All plants going into the synthetic were winter hardy, vigorous, good seed setters, and the roots tended to creep or form rhizomes. The synthetic has a diversity of genetic material.

SC Syn MF3713: A synthetic made up of selections of *Medicago falcata* plants growing wild near Swift Current, Saskatchewan. Plants have sulfur yellow flower color, and fairly good seed set and are nonshattering. Purpose of developing this synthetic was to make available pure seed of *M. falcata* since most other available stocks are mixtures with *M. sativa*.

SC Mass 581: This strain of alfalfa was developed at Saskatchewan out of the cultivar 'DuPuits'. The strain is more winter hardy than the original 'French DuPuits'.

Seed Stocks: Contact B. P. Goplen, Crops Section, Research Station, Saskatoon, Saskatchewan, Canada.

S-2128: A diploid strain of alfalfa, *Medicago sativa* L. (N=16).

S-7311: A white-flowered, seven-clone synthetic.

S-7312: A synthetic developed at Saskatoon, Saskatchewan, with resistance to bacterial wilt and winter crown rot.

UTAH: Contact M. W. Pedersen, USDA, SEA, Crops Research Laboratory, Utah State University, Logan, Utah 84322. Developed cooperatively by the SEA and the Utah AES.

U-5156 and U-5157: Two alfalfa lines with combined resistance to stem nematodes, spotted alfalfa aphids, and bacterial wilt were released for breeding.

U-5156 was developed by crossing the parent clones of 'Uinta' with Lahontan clones C84, C89, and C900 and backcrossing twice to the 'Uinta' clones. In each backcross generation, plants were selected for resistance to spotted alfalfa aphids. The resistant plants were increased and screened in two generations for resistance to stem nematodes and for resistance to bacterial wilt. Percentages

of U-5156 plants resistant to spotted alfalfa aphids and stem nematodes were 69 and 42 percent, respectively.

U-5157 was developed by crossing Uinta clones C924, C925, and C926 with Lahontan clones C84, C89, and C900, and backcrossing three times to 'Uinta'. In each of the three backcross generations, plants were selected for resistance to spotted alfalfa aphid. The resistant plants were increased and screened for resistance to stem nematodes and bacterial wilt. Percentages of U-5157 plants resistant to spotted alfalfa aphids and stem nematodes were 57 and 29 percent, respectively.

Bacterial wilt resistance of either line was not determined, but in view of parentage and selection procedures used, bacterial wilt resistance is expected to be adequate for most conditions. The lines were not evaluated for hay or seed yield.

High and Low Saponin Lines: This release consists of 12 alfalfa lines contrasting saponin characteristics for breeding and experimentation (*44*).

The respective low- and high-saponin lines and the parental cultivars from which they were selected are as follows: U-DPLS4 and U-DPHS4 (LS = low saponin, HS = high saponin) from 'DuPuits'; U-LadLS5 and U-LadHS4 from 'Ladak'; U-LahLS5 and U-LahHS3 from 'Lahontan'; U-RLS5 and U-RHS3 from 'Ranger'; U-ULS3 and U-UHS3 from 'Uinta'; and U-VLS3 and U-VHS3 from 'Vernal'. All 12 lines were developed by recurrent phenotypic selection.

The high-saponin lines from 'Lahontan' and 'Ranger' and the low and high lines from 'Uinta' and 'Vernal' resulted from three cycles of selection. Both saponin lines from 'DuPuits' and the high line from 'Ladak' had four cycles of selection. The low saponin lines from 'Ladak' and 'Lahontan' and the high line from 'Ranger' had five cycles of selection.

In the first cycle of selection, about 1,000 plants each of 'Ladak', 'Ranger', 'Uinta', and 'Vernal' were bioassayed to isolate 25 individuals for intercrossing. In each subsequent cycle, 300 plants were tested and 25 were selected and intercrossed for the next generation. For 'DuPuits' and 'Lahontan', a chemical test was used in the first cycle. Only 100 plants were tested; 5 were selected for intercrossing to initiate the next cycle. The 'Lahontan' lines have less vigor than the parent cultivar. We attribute this lack to the limited germplasm base resulting from crossing only five plants.

The average saponin indices of the low- and high-saponin lines were 32 and 434 percent, respectively, of the average for the parent varieties. In addition to modifying total saponin content, selection also reduced the proportion of more toxic saponin fractions in the low lines and increased them in high lines. In short-term tests, the selected lines were comparable to their respective unselected parents for yield, protein concentration, and in vitro digestibility, except for the forage yield of 'Lahontan'.

These lines are being made available for use in the development of cultivars or hybrids with improved nutritional qualities and for experimental studies of alfalfa saponins.

Utah 5560: Utah 5560 was developed over a period of years by selecting for low saponin concentration based on the *Trichoderma* bioassay. When the bioassays were terminated, five plants each of the low saponin selection from the fifth,

sixth, seventh, and eighth generation of selection out of 'Uinta' and 'Vernal', 'DuPuits', 'Ladak' and 'Ranger', and 'Lahontan', respectively, were selected. Crosses were made in all combinations between cultivars such as 'Ranger' X 'Vernal'. Forty seeds from each of the 15 crosses were bulked, and the plants produced from the seeds were tested for saponin. Twenty-eight plants were selected and interpollinated. About 1,500 plants, produced from the above seeds, were grown for 6 weeks in the greenhouse; inoculated with the bacterial wilt organism by the root soak method; and transplanted to the field. Late in the fall, the plants were dug, and 100 bacterial wilt-free plants were selected and hand pollinated in the greenhouse. U-5560 is similar to 'Ranger' in general appearance and performance.

The crude saponin concentration of U-5560 was 1.49 percent compared with 2.72, 2.12, 1.68, 1.97, 2.55, 2.29, in 'DuPuits', 'Ladak', 'Lahontan', 'Ranger', 'Uinta', and 'Vernal', respectively, in greenhouse grown plants (LSD = .34 P.05). The ED_{50} (concentration of saponin required to reduce *Trichoderma* growth 50 percent) was 1,580 µg/ml for U-5560 compared with 250, 280, 750, 300, 280 and 280 for 'DuPuits', 'Ladak', 'Lahontan', 'Ranger', 'Uinta', and 'Vernal', respectively. A bioassay of the forage showed that U-5560 was 86 percent of the check (culture without alfalfa extract) compared with 29, 36, 75, 44, 28, and 31 for 'DuPuits', 'Ladak', 'Lahontan', 'Ranger', 'Uinta', and 'Vernal', respectively (LSD=3 P.05). The residual saponins in U-5560 have been reduced in quantity by 33 percent and in quality by over 400 percent in toxicity to *Trichoderma* compared with that of the parental cultivars. (See figs. 1-4.)

WASHINGTON: Contact R. N. Peaden, USDA, SEA, Irrigation Agriculture Research and Extension Center, Washington State University, Prosser, Wash. 99350. Developed cooperatively by the SEA and the Washington AES.

WDS3P1 and WIS1P1: These two populations were developed by recurrent phenotypic selection for resistance to stem nematode (*Ditylenchus dipsaci*), Phytophthora root rot (*Phytophthora megasperma*), and bacterial wilt (*Corynebacterium insidiosum*).

WDS3P1 was developed from the cultivar 'Vernal' by three cycles of recurrent phenotypic selection for stem nematode resistance and one cycle of selection for Phytophthora root rot resistance using the S_1 progeny testing technique. All screening and selection was done in the greenhouse, and intercrossed seed was produced with leafcutter bees in a field cage. Approximately 3,000 seedlings were screened each cycle for stem nematode resistance, with approximately 100 plants selected for intercrossing. Following the completion of three cycles of screening for resistance to stem nematode, approximately 4,000 seedlings were exposed to the Phytophthora root rot organism, 108 selections were made, S_1 seed was produced, the progeny were tested in a replicated trial, and the parents of the best seven S_1 lines were selected for intercrossing in a field cage at Prosser. Seed subsequently produced was designated WDS3P1.

WIS1P1 was developed from a hand-pollinated intercross of 43 plants from 'Apalachee' and 30 plants from 'Saranac' selected for high levels of stem nematode resistance in a greenhouse screening, followed by one cycle of selection for Phytophthora root rot resistance. Approximately 3,000 seedlings were screened for Phytophthora root rot resistance and 76 selections were made. S_1 seed was produced, the progeny were tested in a replicated trial, and the parents

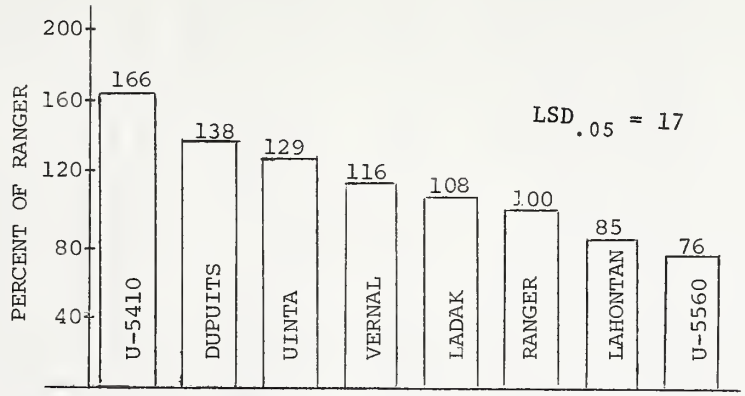

FIG. 1

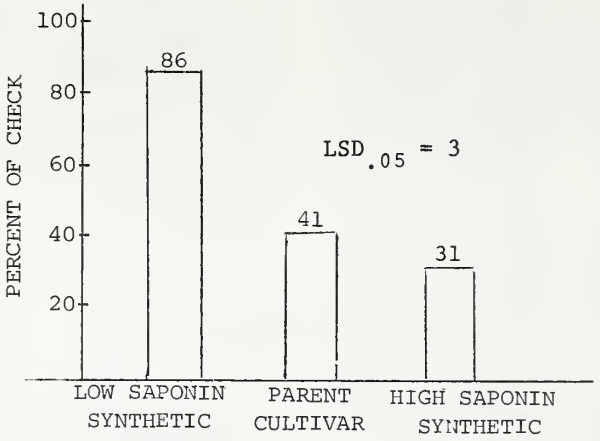

FIG. 2 TRICHODERMA BIOASSAY OF ALFALFA SELECTED FOR LOW OR HIGH SAPONIN COMPARED WITH THE PARENTAL AVERAGE.

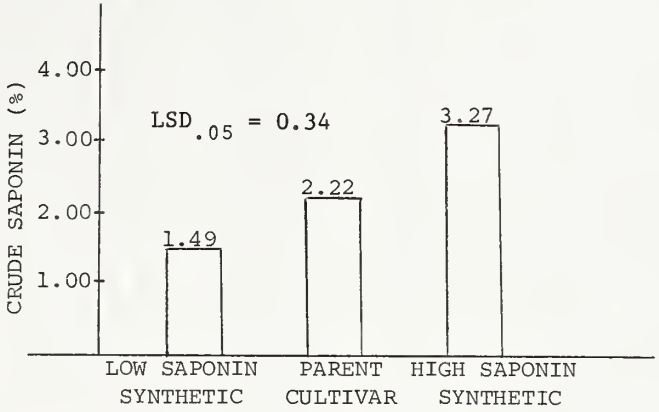

FIG. 3 CRUDE SAPONIN IN ALFALFA SYNTHETICS SELECTED FOR LOW OR HIGH SAPONIN COMPARED WITH THE PARENTAL AVERAGE.

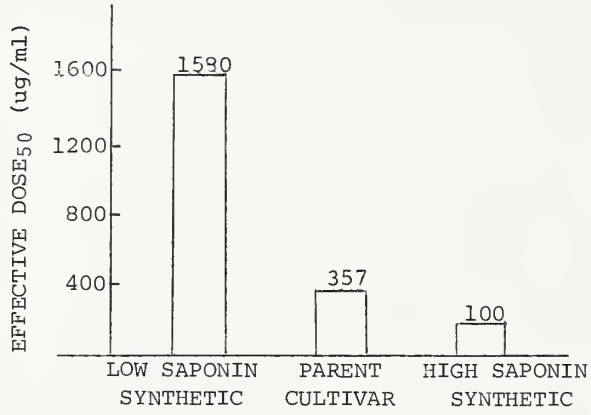

FIG. 4 EFFECTIVE DOSE OF SAPONIN ON TRICHODERMA FOR SYNTHETICS SELECTED FOR LOW OR HIGH SAPONIN COMPARED WITH THE PARENTAL AVERAGE.

of the best 12 S_1 lines were selected for intercrossing in a field cage at Prosser. Seed subsequently produced and increased was designated WIS1P1.

WDS3P1 and WIS1P1 were highly resistant to stem nematode in standard evaluations conducted in the greenhouse at Prosser. Percent resistant plants were as follows: WDS3P1 (81 percent), WIS1P1 (76), 'Washoe' (64), 'Apalachee' (85), 'Saranac' (32), 'Vernal' (17), and 'Ranger' (15). In northern root-knot nematode (*Meloidogyne hapla* Chitwood) evaluations at Prosser, WDS3P1 was found to have a level of resistance similar to 'Vernal'. Percent resistant plants were as follows: WDS3P1 (21), WIS1P1 (N.A.), 'Vernal' (26), 'Apalachee' (0), 'Saranac' (0), and Nev. Syn XX (100).

In evaluations for bacterial wilt resistance at St. Paul, Minn., WDS3P1 was highly resistant while WIS1P1 had low resistance. Percent resistant plants were as follows: WDS3P1 (44), WIS1P1 (14), 'Vernal' (35), 'Apalachee' (0), 'Saranac' (28), and 'Ranger' (17). In evaluations for Phytophthora root rot resistance, also at St. Paul, WDS3P1 has been highly resistant while WIS1P1 was considered moderately resistant. Percent resistant plants were as follows: WDS3P1 (64), WIS1P1 (32), 'Vernal' (6), 'Apalachee' (4), 'Saranac (2), and 'Agate' (47).

Stem Nematode Resistant Populations: Eighteen alfalfa populations highly resistant to stem nematode (*Ditylenchus dipsaci*) were released to provide plant breeders with sourches of stem nematode resistance with diverse genetic background for use in alfalfa growing areas of northwestern United States. The released populations were WAS3, WCS3, WDS3, WFS3, WGS3, WHS3, WIS3, WJS1, WLS1, WMS1, WRS1, WUS1, WXS1, WYS1, WZS1, W1S1, W2S2, and W8SO.

WAS3 traces to the cultivar 'Team', WCS3 to Nevada Syn Y (which traces to bacterial wilt resistant selections from P.I. 211608), WDS3 to 'Vernal', WFS3 to 'Williamsburg', WGS3 to 'Talent', WHS3 to P.I. 141462, and WIS3 to 'Lahontan'. Each germplasm pool was developed by three cycles of recurrent phenotypic selection for resistance to stem nematode. W2S2 traces to 'Arc' and was developed by two cycles of recurrent phenotypic selection. WJS1, WLS1, WMS1, and WRS1 trace to the cultivars 'Saranac', 'Scano', 'Aragon', and 'Nematol I', respectively, and were developed by one cycle of phenotypic selection. In all 12 populations, about 3,000 plants were observed for resistance to stem nematode under greenhouse conditions, and approximately 100 plants were selected in each cycle of selection.

WUS1 was developed from an intercross of 33 plants tracing to 'Nemastan' (9), 'DuPuits' (8), 'Lahontan' (5), 'Resistador' (5), 'Vernal' (2), 'Caliverde 65' (2), 'Ranger' (1), and 'Moapa' (1), which were selected for stem nematode resistance after repeated inoculations in the greenhouse. WXS1 was developed from an intercross of 10 clones (Nevada clones 66-58, 66-74, 66-79, 66-103, 66-75, 66-55, 66-53, 66-68, 66-78, and 66-25, which trace to 'Lahontan' X 'Vernal' crosses with selection for foliar disease and bacterial wilt resistance). These clones were stem nematode resistant after 3 years in a spaced planting in the field at Prosser; their polycross progeny yielded well there in single-row trials. WYS1 was developed from an intercross of 91 plants tracing to 'Washoe' (10), 'Apalachee' (5), 'Williamsburg' (7), 'DuPuits' (3), 'Cherokee' (6), 'Vernal' (2), 'Team' (2), 'Dawson' (1), and to experimental Nevada lines (55), which were selected for stem nematode resistance and good fall and spring growth from single-row and multiple-row plots at Prosser.

WZS1 was developed from an intercross of 39 plants tracing to Nevada Syn Y (5), 'Scano' (5), 'Aragon' (3), Nevada Syn. WW (3), 'Williamsburg' (1), 'Talent' (2), 'DuPuits' (5), P.I. 141462 (1), Nevada Syn EE (5), 'Nematol' (3), 'Apalachee' (5), and 'Lahontan' (1), which were selected for stem nematode resistance, good fall and spring growth, and high stem number after 2 years in a spaced plant field nursery at Prosser. W1S1 was developed from an intercross of 73 plants tracing to 'Apalachee' (43) and 'Saranac' (30), which had demonstrated high stem nematode resistance after repeated inoculations in the greenhouse. W8SO was developed by blending equal quantities of seed of WAS3, WCS3, WDS3, WES3 (developed from root-knot nematode resistant Nevada Syn WW), WFS3, WGS3, WHS3, and WIS3, planting, and intercrossing for seed increase.

All intercross seed for the 18 germplasm pools was produced with leafcutter bees in field cages at Prosser.

All 18 populations were highly resistant to stem nematode in standard evaluations conducted in the greenhouse at Prosser. Percent resistance in the populations ranged from 72 to 86 as follows: WAS3 (72), WCS3 (74), WDS3 (85), WFS3 (74), WGS3 (79), WHS3 (84), WIS3 (76), WJS1 (80), WLS1 (73), WMS1 (85), WRS1 (85), WUS1 (74), WXS1 (76), WYS1 (86), WZS1 (84), W1S1 (83), W2S2 (86), W8SO (84), 'Apalachee' (85), 'Washoe' (64), 'Saranac' (32), 'Vernal (17), and 'Ranger' (15).

In northern root-knot nematode evaluations at Prosser, percent resistance ranged from 0 to 30 as follows: WAS3 (7), WCS3 (0), WDS3 (30), WFS3 (9), WGS3 (6), WHS3 (0), WIS3 (7), WJS1 (6), WLS1 (5), WMS1 (4), WRS1 (2), WUS1 (4), WXS1 (5), WYS1 (3), WZS1 (4), W1S1 (9), W2S2 (3), W8SO (22), 'Vernal' (26), 'Saranac' (0), and Nevada Syn XX (100).

Seven of the populations have been evaluated for bacterial wilt [*Corynebacterium insidiosum* (McCull.) H. L. Jens.] resistance and five for Phytophthora root rot (*Phytophthora megasperma* Drechs.) resistance in standard evaluations at St. Paul. Percent resistant plants for bacterial wilt were as follows: WDS3 (31), WUS1 (6), WXS1 (22), WYS1 (13), WZS1 (1), W1S1 (16), W2S2 (6), 'Vernal' (35), 'Ranger' (17), and 'Narragansett' (0). Percent resistant plants for Phytophthora root rot were as follows: WXS1 (14), WYS1 (13), WZS1 (11), W1S1 (14), W2S2 (9), 'Vernal' (6), 'Saranac' (2), and 'Agate' (47).

WISCONSIN: Contact E. T. Bingham, Department of Agronomy, University of Wisconsin, Madison, Wis. 53706. Developed by the Wisconsin AES, Madison.

W6XGP-1 (Hexaploid Stocks) (5): Hexaploid alfalfa (2n=6x=48) *Medicago sativa* L. provides many new opportunities for both theoretical and applied research. A population of hexaploid alfalfa carrying diverse germplasm was developed and released as W6XGP-1 by the University of Wisconsin for breeding and other research.

Original hexaploid (6x) plants were isolated among varietal plants of Saranac (*3*) and were likely produced by the union of reduced (2x) and unreduced (4x) gametes. Subsequent 6x plants were produced by crossing triploids ($2n=3x=24$) of diverse origin with the original hexaploids (*7*). Most progeny of 3x-6x crosses were hexaploids produced by the union of unreduced triploid gametes (3x) and reduced hexaploid gametes (3x). Triploids used were derived from (1) haploid(2x)-tetraploid(4x) crosses, in which case all three genomes were originally from cultivated alfalfa, and (2) from 4x-2x crosses where the 2x parent was *M. falcata*.

Hence, haploids of tetraploids and triploids are both uniquely valuable in the transfer of germplasm to the hexaploid level.

The original and triploid-derived hexaploids were vigorous, chromosome associations were mostly bivalents, pollen stainability was good, and they were self- and cross-fertile (7). Twelve plants descending from these hexaploids were intercrossed by hand in the greenhouse to produce seed of W6XGP-1. This germplasm is similar to Syn E (7) and is approximately four-sixths 'Saranac', one-sixth 'Vernal', one-twelfth 'African', and one-twelfth *M. falcata*. Flower color ranges from very light purple through dark purple and variegated.

W6XGP-1 is now being observed in its first growing season in the field; it has not undergone screening and selection for disease resistance or agronomic characteristics. It is similar to cultivated varieties in seedling vigor, plant height, and time of flowering; however, it has larger leaves and flowers and, in general, has less axillary branching than most varieties. The two original Saranac-derived clones were winter hardy at Madison in 1968 and 1969, whereas the triploid clones carrying African germplasm were not hardy. Hence, it should be possible to select plants with a wide range of hardiness and other characteristics out of W6XGP-1.

W70-22, W71-42, W71-47, and W72-48 (6): Four experimental populations, W70-22, W71-42, W71-47, and W72-48, were developed and released by the College of Agriculture and Life Sciences, University of Wisconsin. All populations were mainly hybrids between cultivated alfalfa *Medicago sativa* L. and wild diploid *M. falcata* L. This release is unique because, in the case of W70-22 and W71-42, the germplasm is available at diploid and tetraploid levels, respectively.

Materials with P. I. numbers were obtained from the North Central Regional Plant Introduction Station at Ames, Iowa, and included 16 *M. falcata* and 3 *M. sativa* lines (table 9). All had been reported in publications, regional reports, and personal communication to have tolerance or resistance to the alfalfa weevil. Variegated tetraploids commonly found in the lines were not included in crosses. Interploid hybrids were produced by 4x-2x and 2x-4x hand cross pollinations on maternal parents kept in the greenhouse. Tetraploid hybrids from either cross were presumably produced by functioning of gametes with the unreduced chromosome number (2n gametes) from the diploid parent (*4*). The few triploid hybrids produced were identified by sterility.

W70-22 was produced by crossing 2x haploids derived from cultivated alfalfa with the 2x *M. falcata* lines indicated (table 9). Diploid W70-22 and tetraploid W71-42 are in the same cytoplasm and have 75 percent *M. falcata* genes and about 50 percent *M. sativa* genes in common. Intended use of W70-22 is breeding for weevil resistance at the diploid level. The diploid yields about half as much vegetatively as the tetraploids and produces heavy first crop and less in succeeding crops, which is typical of experimentals containing *M. falcata* . All populations are winter hardy in Wisconsin, but are less than half as resistant to bacterial wilt as their cultivated tetraploid parents. Diploid W70-22 is very low in wilt resistance.

In weevil tests at Evansville, Wis., and Powell, Wyo., W71-42 and W71-47 had about the same number of weevils per sweep and degree of weevil feeding damage in solid stands as standard cultivars. Hence, they are not resistant on a population basis, but individual resistant or tolerant plants may be segregating in the populations.

W72-48 was designed to approach maximum genetic diversity in a germplasm pool. It contains all the germplasm from W71-42 plus that from *M. falcata* representing five different regions in the U.S.S.R. However, due to evidence accumulating in our project supporting the association of maximum heterozygosity and yield, we are ceasing to pool such diverse materials and are keeping components separate until two generations before the cultivar stage.

W71-47, in contrast to the others, has a very narrow germplasm base consisting of three different maternal Saranac clones and nine plants of P.I. 231731, which survived 6 years in a bacterial wilt nursery at Madison. P.I. 231731 has multiple pest resistance, and a chance hybrid from this line is in the parentage of the cultivar 'Weevlchek'.

Medicago falcata: Wisconsin 2x accessions from U.S.S.R. (Denin, Kuban, Maikop, Pakov, and Siberian regions).

Diploid Stocks: This germplasm is *M. falcata* adapted to Wisconsin and cultivated alfalfa *M. sativa* and *M. dzawkhetica* at the diploid level.

Genetic Stocks (C2): White flowered, white seeded, basic color factor recessive, which is nonallelic to Stanford's color factor recessive. It was discovered at 2x level and transferred to 4x level. Referred to as C2.

CAL/WEST SEEDS: Contact Donald Smith, Cal/West Seeds, P. O. Box 1428, Woodland, Calif. 95695.

R-4: A nondormant, wilt resistant, very high seed yielding population of plants.

V-119: A nondormant, wilt resistant, high seed yielding population with some resistance to leaf diseases.

NORTHRUP, KING AND CO.: Contact Howard E. Kaerwer, Manager, Research Service Department, Northrup, King and Co., 1500 Jackson St., N. E. Minneapolis, Minn. 55413.

1-N6-96: This germplasm was an introduction from Germany as Saure Lucerne No. 1 and was identified as being tolerant to acid soils and tolerant to aluminum and manganese toxicity.

PIONEER HI-BRED INTERNATIONAL, INC.: Contact Marvin K. Miller, Pioneer Hi-Bred International, Inc., Plant Breeding Division, Department of Alfalfa Breeding, 5151 N. Palm, Suite 50, Fresno, Calif. 93704.

68CC: A nursery of plants from plant introductions was established in 1963 at Five Points, Calif. Pod samples were collected in 1964 and 1965 from 657 plants and examined for number of emerged chalcids. Plants were also given visual scores for seed set and for spotted alfalfa aphid reaction. Fourteen plants from seven plant introductions were selected and cloned to form the first cycle germplasm pool under cage. The origin of the plants was as follows:

TABLE 9.--*Parental information for one diploid and three tetraploid synthetics at Madison, Wis.*

P.I. numbers	P.I. ploidy levels	Origin	Experimental synthetics			
			Diploid	Tetraploid		
			W70-22	W71-42	W71-47	W72-48
Medicago falcata						
172980	[1]2x, 4x	Turkey	x	x		x
204886	[1]2x	--do--	x	x		x
228152	[1]2x	U.S.S.R.	x	x		x
231731	[1,2]2x	U.S.S.R. via Wisconsin	x	x	x	x
234815	[1]2x	Switzerland	x	x		x
234817	[1]2x	--do--	x	x		x
234818	[1]2x	--do--	x	x		x
235021	[1]2x	--do--	x	x		x
251205	[1]2x, 4x	Yugoslavia	x	x		x
251689	[1]2x	U.S.S.R.	x	x		x
251830	[1]2x, [1]4x	Austria	x	x		x
253443	[1,2]4x	Yugoslavia		x		x
258750	[1]2x	U.S.S.R.	x	x		x
260993	[1]2x	--do--	x	x		x
262532	[1]2x	Israel	x	x		x
263154	[1]2x	U.S.S.R.	x	x		x
M. sativa						
239953	[1]4x	Algeria		x		x
277489	[1]4x	Spain		x		x
277705	[1]4x	Italy		x		x

[1]Ploidy level used in crosses. Ploidy levels were mostly determined by fertility in crosses with known tetraploids.

[2]Ploidy level established by both crossability and root-tip chromosome count.

Introduction	Origin	No. of selections
P.I. 173728	Turkey	1
P.I. 196220	India	1
P.I. 196225	--do--	1
P.I. 196231	--do--	1
P.I. 212858	Afghanistan	6
P.I. 235245	Spain	1
P.I. 243223	Iran	3

A nursery was planted in 1967 with polycross seed of the 14 plants selected. Twenty-three plants were selected based on chalcid score, growth, reaction to the spotted alfalfa aphid, and seed set score. The 23 plants were cloned, and a polycross was produced under cage, which was designated 68CC.

The germplasm 68CC is variable in growth but mostly of the Southwest type with intermediate dormancy. It carries resistance to the seed chalcid and the spotted alfalfa aphid.

WATERMAN-LOOMIS COMPANY: Contact D. F. Beard, Vice-President Research, Waterman-Loomis Company, 10916 Bornedale Drive, Adelphi, Md. 20783.

Bulk Hybrid (Male Sterile Germplasm): This germplasm represents genetic male sterile clones derived from crosses of the genetic male sterile germplasm, 20 DRC, with normal male parents possessing pea and spotted alfalfa aphid resistance. The 29 male steriles which looked the best, out of more than 100 that were evaluated, were grown in a large polycross block (more than 300 clones), and the hybrid seed were harvested and bulked to make up the Bulk Hybrid. The seed should be duplex for both sterility factors in 20 DRC as described by Childers (*10*).

Clonal Stocks

CALIFORNIA: Contact L. R. Teuber, Department of Agronomy and Range Science, University of California, Davis, Calif. 95616.

M-9, A-14 and 81-1: Developed by the California AES, University of California, Davis. M-9 is a single plant selection from the cultivar 'Vernal' and is winter dormant in growth habit. It is resistant to all collections of root-knot nematode tested in California including 2 collections of *Meloidogyne hapla*, 10 collections of *M. incognita*, and 8 collections of *M. javanica*. Resistance to *M. hapla* is determined by a single dominant gene, and resistance to *M. javanica* is determined by a second dominant gene linked to the *M. hapla* resistance gene (*20*, *21*).

A-14 is a single plant selection from P.I. 141462, an introduction from Iran, and is nondormant in growth habit. It was highly resistant to all collections of stem nematode from 11 locations in California. Resistance is determined by a single dominant gene (*23*).

81-1 is a single plant selection from seed progeny of a polycross plot consisting of plants from 'Caliverde' X ('California Common 49' X 'Caliverde'). It

has a high level of resistance to the pea aphid, which is determined by a single major dominant gene (*19*).

C937: Developed by the California AES, University of California, Davis, in cooperation with the SEA and the AES of Arizona and Nevada (*40*).

C937 is a single plant selection made by W. F. Lehman in the fall of 1956 from a one-year-old field planting of African alfalfa located on the Lloyd Parish farm, Imperial, Calif. It is one of the parents of the cultivars 'Sonora', 'El Unico', and Moapa 69' and of numerous experimental cultivars and hybrids.

C937 is resistant (++) to biotypes ENT A and ENT B of the spotted alfalfa aphid (*Therioaphis maculata*). It has good general combining ability when compared with that of 'Moapa' in restricted polycross tests. In representative tests grown at El Centro and Davis yields were 111 percent of 'Moapa'. C937 has some resistance to pea aphids (*Acyrthosiphon pisi*) as shown in comparisons at El Centro where scores of 1.7, 4.1, 3.2, and 1.7 were obtained for C937 polycross progeny, 'African', 'Moapa', and 'Sonora', respectively. In stem counts made at Mesa, Ariz., an average of 44 percent fewer pea aphids was found on C937 than on 'Moapa'. Progeny from crosses between C937 and plants susceptible to downy mildew (*Peronspora trifoliorum*) were classified in Prosser tests and found to be highly resistant to the fungus. Scores made at El Centro for reaction to downy mildew were: 2.0, 4.3, 4.8, and 2.2 for C937 polycross progeny, 'African', 'Moapa', and 'Sonora', respectively. In a replicated clonal nursery with 27 entries selected from African, C937 scored 1.2 where the range in the nursery was 1.1 to 4.6. Seed production of C937 was good in comparisons with other nondormant clones. Some self-pollination was observed. C937 has a moderate to short stand life in general comparisons but good clone life when compared with nondormant clones of African origin. It has an upright growth habit. It is susceptible to *Sclerotinia trifoliorum*. In tests for bacterial wilt (*Corynebacterium insidiosum*) made at Reno, 5 to 10 percent of its progeny from restricted polycross tests were classed as resistant. It is highly resistant to root-knot nematode (*Meloidogyne javanica*). In a greenhouse test, 97 percent of its polycross progeny were resistant in a test where 100 percent of the check plants showed infection.

MINNESOTA: Contact D. K. Barnes, USDA, SEA, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minn. 55108.

59-126-1, 59-126-2, and 59-126-3: Developed by the Minnesota AES and SEA, St. Paul. 59-126-1, 59-126-2, and 59-126-3 are three clones of *Medicago tunetana* Murb. that are resistant to the black stem organism *Phoma herbarum* var. *medicaginis (Ascochyta imperfecta)* and to the leafspot organism *Leptosphaerulina briosiana (Pseudoplea medicaginis)*. The clones were selected in 1949 from old seed of a plant introduction (S.P.I. 28646) made in 1910 from Oued Zenati, Algeria.

In greenhouse tests for resistance to *Phoma*, the three clones were consistently superior to any previously observed in *M. sativa* or releated species. When tested for resistance to *Leptosphaerulina*, all were resistant, but clone 59-126-2 was the most resistant, exceeding any previously noted in alfalfa. The clones have not been evaluated for resistance to other pathogens.

Although *M. tunetana* was described as a distinct species, cytogenetic studies at St. Paul indicated that the three clones belong to the interfertile, polymorphic *Falcago* complex. When crossed with cultivated alfalfa, seed set was

normal and progenies had satisfactory levels of fertility. The clones are not sufficiently winter hardy in most of the north central region. Transfer of resistance to adapted stocks will be necessary to fully utilize this source of resistance. The clones are semiupright and fine stemmed and have variegated flowers. Pods are coiled and moderately pubescent.

NEVADA: Contact O. J. Hunt, USDA, SEA, Division of Plant, Soil and Water Science, University of Nevada, Reno, Nev. 89557.

C89 and N-529: Developed by the SEA in cooperation with the Nevada AES, University of Nevada, Reno (*29*). C89 is an alfalfa selection from Nemastan with high general combining ability for several characters. It is one of the five parents of the variety 'Lahontan'. C89 is highly resistant to the stem nematode and to biotypes ENT A and ENT B of the spotted alfalfa aphid. It is moderately resistant to bacterial wilt and the pea aphid. Studies in 1961 and 1962 by the SEA at Mesa, Ariz., indicated that C89 may also have moderate resistance to the alfalfa seed chalcid. Chalcid infestation of C89 was about 40 percent as heavy as that observed on other parent clones of 'Lahontan', a cultivar which tends to be less damaged by this insect than other cultivars. Like Nemastan and other Turkistan alfalfas, C89 is susceptible to leaf and stem diseases.

N-529 is a second-cycle derivative from 'Nemastan' and is one of the parents of the pea aphid resistant cultivar 'Washoe'. N-529 is highly resistant to pea aphids, to biotypes ENT A and ENT B of the spotted alfalfa aphid, to bacterial wilt, and to stem nematodes. Like 'Nemastan' and 'Lahontan', it is susceptible to leaf and stem diseases. It has produced more seed at Reno than any of the parents of 'Lahontan'.

MARYLAND: Contact J. H. Elgin Jr., USDA, SEA, Crops Research Laboratory, BARC-West, Beltsville, Md. 20705.

BW1603, BW1839, and BW3269: Developed by the SEA. BW1603, BW1839, and BW3269 are three clones that have moderate resistance to the alfalfa weevil and were developed by the SEA, Beltsville. They have been made available to entomologists and breeders for use as breeding materials and as standards of comparison for laboratory studies of resistance to larval development. In laboratory tests, average weight per surviving larva after 8 days feeding on these clones was about 40 percent less than that on susceptible clones.

The clones were selected from more than one-half million plants observed for weevil reaction in field and laboratory tests. Clones (vegetative propagules) were then evaluated in four larval development tests totaling 26 replications. Each evaluation consisted of placing 10 newly hatched larvae on a plant, enclosing it within a plastic cage, and counting and weighing surviving larvae after 8 days. Tests were conducted in controlled growth rooms at 21° C. These clones retard larval development of both eastern and western strains of the alfalfa weevil. The mechanism of resistance has not been determined.

BW1603 and BW1839 are non-winter hardy selections from the Peruvian ecotypes Magate and Monsefu, respectively. BW 3269 is a selection from the experimental population MSHp5, which was initiated in 1957 at Raleigh, N.C., when 66 field selected plants of diverse origin were intercrossed. One subsequent cycle of field selection for weevil resistance was conducted in North Carolina and two cycles at Beltsville. Clone BW3269 is sufficiently winter hardy for

Maryland conditions. Susceptible check clones to be included with this release (BW6083, BW6208, and BW6223) are all field selections from old alfalfa stands of adapted but unknown varieties in Maryland.

Ozone Resistant and Susceptible Clones: Nine alfalfa clones resistant and five clones highly susceptible to ozone injury were developed cooperatively by the SEA, Plant Air Pollution Laboratory and Alfalfa Investigations, Beltsville. They are being made available for studies of plant resistance to ozone and for use in development of cultivars or hybrids with improved resistance to air pollution.

Five of the nine ozone-resistant clones were selected from MSB CW_5 AN_2, a germplasm pool developed by 19 cycles of recurrent phenotypic selection for resistance to the following disease and insect pests: Anthracnose, bacterial wilt, common leafspot, potato leafhopper yellowing, and rust (*24*). Four Ozone-resistant clones and one susceptible clone were selected from 'Team'. Four ozone-susceptible clones were from 'Williamsburg'. Results of performance tests are shown in table 10.

To screen for ozone sensitivity, more than 150 plants of each population or variety were exposed to 20 parts per hundred million of ozone for 4 hours in a fumigation chamber at 26° C, 92 ± 2 percent relative humidity, and 2,000 foot-candles luminescence (*28*).

ONTARIO, CANADA: Contact W. R. Childers, Ottawa Research Station, Central Experimental Farm, Ottawa, Ontario, Canada K1A0C6.

Male Sterility Germplasm (20 DRC): Characterized by an atypical behavior after microspores were released from tetrads, was described by Childers and McLennan (*10*). Complete degeneration of microspores follows release of microspores from the tetrads. The stage at which this degeneration occurs is later than the stage at which the nondehiscent-type male sterility occurs. Function of the female gametophytes of plants with degenerate microspores was normal. This type of complete male sterility was shown to be controlled by one gene, ms_3 (*41*). The following clonal germplasm has been released for breeding:

20 DRC Tetraploid N=32
20 DRC Diploid N=16
20 DRC Dihaploid N=16, male sterile
20 DRC White flowered, male sterile
20 DRC Pale-yellow flowered, male sterile
20 DRC Pale-blue flowered, male sterile

SASKATCHEWAN, CANADA: Contact B. P. Goplen, Crops Section, Research Station, Saskatoon, Saskatchewan, Canada.

Sask Rd: Two clones of a genetic red root character developed at the Research Station, Canada Agriculture, Saskatchewan.

SOUTH DAKOTA: Contact the Plant Science Department, South Dakota State University, Brookings, S. D. 57006.

C 618: A dense, cold resistant, winter resistant and leafspot resistant clone.

TABLE 10.--*Mean injury scores for alfalfa clones selected for resistance or high susceptibility to ozone at Beltsville, Md.*[1] *Within each of the three sources, clones are arranged in order of increasing magnitude of mean score over tests*

Clone		Treatment atmosphere				
				Ambient air[3]		
		Ozone[2]		Greenhouse[4]		Field[5]
Identification	Source	10/6/71	11/10/71	7/26/71	9/2/71	8/12/71
Resistant Clones						
2-1-2H	MSB-CW5An2	1.0	1.0	0.4	1.0	1.0
2-4-1H	--do--	1.0	3.6	.4	1.0	.5
2-1-3H	--do--	4.6	2.5	1.8	2.2	.5
2-3-2H	--do--	3.2	3.2	4.0	4.0	2.5
2-2-3H	--do--	6.4	3.4	2.0	4.8	.8
10-1-3H	Team	2.2	2.8	3.2	2.2	1.7
10-4-4H	--do--	5.0	5.6	2.6	1.6	3.0
10-3-4H	--do--	3.2	5.4	3.8	4.6	4.2
10-3-2H	--do--	3.8	3.8	5.0	5.8	3.8
Susceptible Clones						
11-3-2L	Williamsburg	7.6	8.8	6.2	8.0	6.5
11-1-2L	--do--	7.4	8.4	7.0	7.8	-
11-1-1L	--do--	8.2	8.4	8.2	9.0	7.7
11-4-3L	--do--	9.0	9.0	8.6	9.0	8.8
10-1-1L	Team	8.6	8.6	8.6	8.6	7.8
LSD (.05)		2.4	2.9	2.1	1.6	2.1
(.01)		3.2	3.8	2.8	2.2	2.7

[1]Scored 0 to 9; 0 = no injury.

[2]Controlled chamber fumigation, 20 parts per hundred million of ozone for 4 hours, 5 replications.

[3]Ambient air (Beltsville). Total oxidant concentration, determined by Mast 7-242 sensor, for 10-h periods (9-6) on 10 days prior to scoring were 5.0, 3.3, and 3.5 respectively. Ozone estimated to be 85 to 90 percent of total oxidant.

[4]Nonfiltered air modified by wet pad cooling system, 5 replications.

[5]Field test with plants spaced on 30-inch centers, 4 replications, Beltsville.

C 639: One of the parent clones of the cultivar 'Teton', which is highly resistant to *Pseudopeziza medicaginis* and is very winter hardy.

C 640: Similar to C 639 but more like the *Medicago falcata* phenotype.

S.D. Ck 25-1: One of the parent clones of the cultivar 'Travois'. It has high resistance to bacterial wilt and much root proliferation.

S.D. Ck 27-1: Similar to S.D. Ck 25-1 but is more of the *M. falcata* type.

S.D. AR-4: Highly resistant to the spotted alfalfa aphid, with excellent seed and forage yield.

UTAH: Contact M. W. Pedersen, USDA, SEA, Crops Research Laboratory, Utah State University, Logan, Utah 84322. Developed cooperatively by the SEA and the Utah AES.

1292A, 1293A, 2B and 55B: Two clones, which are cytoplasmic male steriles, and two maintainer clones were released to permit greater study of forage and seed potential of alfalfa hybrids and to enhance development of a successful hybrid alfalfa industry (*43*).

The male steriles, 1292A and 1293A, were isolated from the cultivar 'DuPuits'. They were characterized by nondehiscent anthers and a low percentage of fertile pollen. No seed was obtained from selfing 1292A, and its pollen was not functional in crosses with a recessive marker line. Nine seeds were obtained from extensive selfing of 1293A; an occasional hybrid was obtained from extensive selfing of 1293A, and an occasional hybrid was obtained from pollinating a recessive marker with pollen of 1293A. No seeds were obtained in crosses between 1292A and 1293A. Both plants are vigorous. They are moderately good seed producers in fertile crosses and set an average number of seeds per pod when hand pollinated.

Maintainer clones, 2B and 55B, have moderate vigor and are excellent seed producers. They have a high percentage of stainable pollen. Anther dehiscence is normal. Clone 55B is one of the parent clones of 'Uinta'. Clone 2B is from an open-pollinated progeny of A-225.

F_1 plants from crosses between 1293A and either 2B or 55B are male sterile. Percentages of male sterile plants in backcrosses to 2B and 55B were 86 and 95 percent, respectively. Percentage of male sterile F_1 plants were 83 and 91 percent from 1292A x 2B and 1292A x 55B, respsectively; 81 and 90 percent of the corresponding backcross plants to 2B and 55B were male sterile. Seed production on sterile F_1 combinations pollinated by bees is less than on fertile combinations, but not so much impaired as to discourage their use.

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GLOSSARY

Average Severity Index: measure of the severity of disease based on an average damage or severity score of plants examined.

Backcross: cross between an F_1 hybrid and either of its parents.

Biotype: group of genetically identical individuals.

Bivalent: pairing configuration, during the first meiotic division, that consists of two completely or partially homologous chromosomes.

Breeding lines: group of individuals from a common ancestry; a more narrowly defined group than a strain or variety.

Broad-based population: population or group of related individuals that are derived from many distinct and diverse parents.

Clone: all individuals derived from a common parent by vegetative propagation.

Creeping rooted: characteristic of a plant to produce horizontal roots.

Cross pollination: transfer of pollen from an anther on one plant to a stigma in a flower on a different plant.

Cultivar: variety of a cultivated plant (see Preface for detailed definition).

Cytoplasmic male sterility: male sterility caused by the cytoplasm rather than by nuclear genes; transmitted only through the female genes.

Diploid: having two sets of chromosomes. Vegetative tissues of plants are ordinarily diploid.

Dormant: internal condition of dormancy; a resting state that must be "broken" by time or special conditions before a bud will grow at temperatures and moisture levels suitable for growth. In alfalfa, the vegetative dormancy of a plant may be conditioned by day length or temperature.

Duplex: genetic condition in which a polyploid individual is dominant for two alleles with respect to a particular gene.

Gene frequency: proportion of one particular type of allele to the total of all alleles at this genetic locus in a breeding population.

Genetic recombination: formation of new gene combinations following crosses between genetically different parents.

Germplasm: potential hereditary materials within a species, line or population taken collectively.

Germplasm pool: collection of germplasms artifically composited to provide a source for specific breeding purposes.

Haploid: cell or organism with the gametic chromosome number (1N) having a single set of chromosomes in a cell as individual or as in a gamete.

Hardy: relative ability to withstand low temperatures--often used in describing vegetative dormancy in alfalfa.

Heterozygosity: condition of having unlike alleles at one or more corresponding loci.

Hexaploid: having six sets of chromosomes; polyploidy.

Inbred: result of mating between relatives.

Independent culling: selection of individuals, each possessing all of the desired characters.

Interploid: polyploid resulting from hybridization of two distinct ploidy levels; the mating and resultant progeny of the mating of individuals with different ploidy levels.

Linkage: association of characters in inheritance due to location of genes in proximity on the same chromosome.

Maintainer clone: clone that carries a gene that at least superficially recoups the changes brought about by a cytoplasmic induced sterility.

Microspores: four haploid spores originating from the meiotic division of the microspore mother cell in the anther, which gives rise to the pollen grain.

Nonallelic: two contrasting genes that occupy different corresponding positions on the two members of paired chromosomes.

Nondehiscent: failure of flowers or flower parts to open.

Nondormant: classification of plants that do not go into a resting state induced by low temperatures or photoperiodism (see dormant).

Nonhardy: relative inability to withstand low temperatures (see hardy)--often used in describing dormancy.

Nulliplex: condition in which a polyploid is recessive for all alleles in respect to a particular gene.

Oviposition: process of depositing eggs by an insect.

Phenotype: appearance of an individual as contrasted with its genetic makeup or genotype. Similar phenotypes are not necessarily genetically identical.

Pleiocotyly: many cotyledons.

Ploidy: degree of repetition of the basic number of chromosomes.

Polycross: open pollination of a group of selected genotypes in isolation from other compatible genotypes in such a way as to promote random mating among themselves.

Polysomic: having one or a few chromosomes present in greater or smaller number than the rest.

Population: community of individuals that share a common gene pool.

Polymorphic: state or occurrence in the same population of two or more distinct forms at frequencies too great to be explained by recurrent mutation.

Quadruplex: condition in which a polyploid is dominant for all alleles at a loci.

Recombinant population: a population of individuals arising as a result of interchromosomal and intrachromosomal genetic recombination.

Recombination: any process that gives rise to individuals; associating in new ways two or more hereditary determinants by which their parents differed.

Recurrent phenotypic selection: method of breeding designed to concentrate favorable genes scattered among a number of individuals by selecting in each generation among the progeny based upon phenotype and mating among themselves the selected individuals.

Resistance: process and characteristic of a host plant such that it is capable of suppressing or retarding the development of a pathogen or other injurious factor.

Rhizomatous: state of possessing underground stems, usually horizontal and often elongated, distinguished from roots by the presence of nodes and internodes and sometimes scalelike leaves and buds at the nodes.

S_1: symbol for designating the first selfed generation.

Simplex: genetic condition in which a polyploid is dominant for one allelle at a locus.

Successive elimination: the selection or elimination of specific individuals from one generation to another.

Susceptible: characteristic of a host plant such that it is incapable of suppressing or retarding an injurious pathogen or other factor.

Strain: group of similar individuals within a variety.

Synthetic variety: a variety produced by crossing, among themselves, a number of genotypes selected for good combining ability in all possible hybrid combinations, with subsequent maintenance of the variety by open pollination.

Tetrasomic: polysomic cells or individuals with one chromosome represented four times instead of twice in an otherwise diploid.

Triplex: genetic condition in which a polyploid is dominant for three alleles at a locus.

Triploid: organism with three basic (x) sets of chromosomes.

Tolerance: ability to endure infection by a particular pathogen without showing severe disease (see resistance).

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